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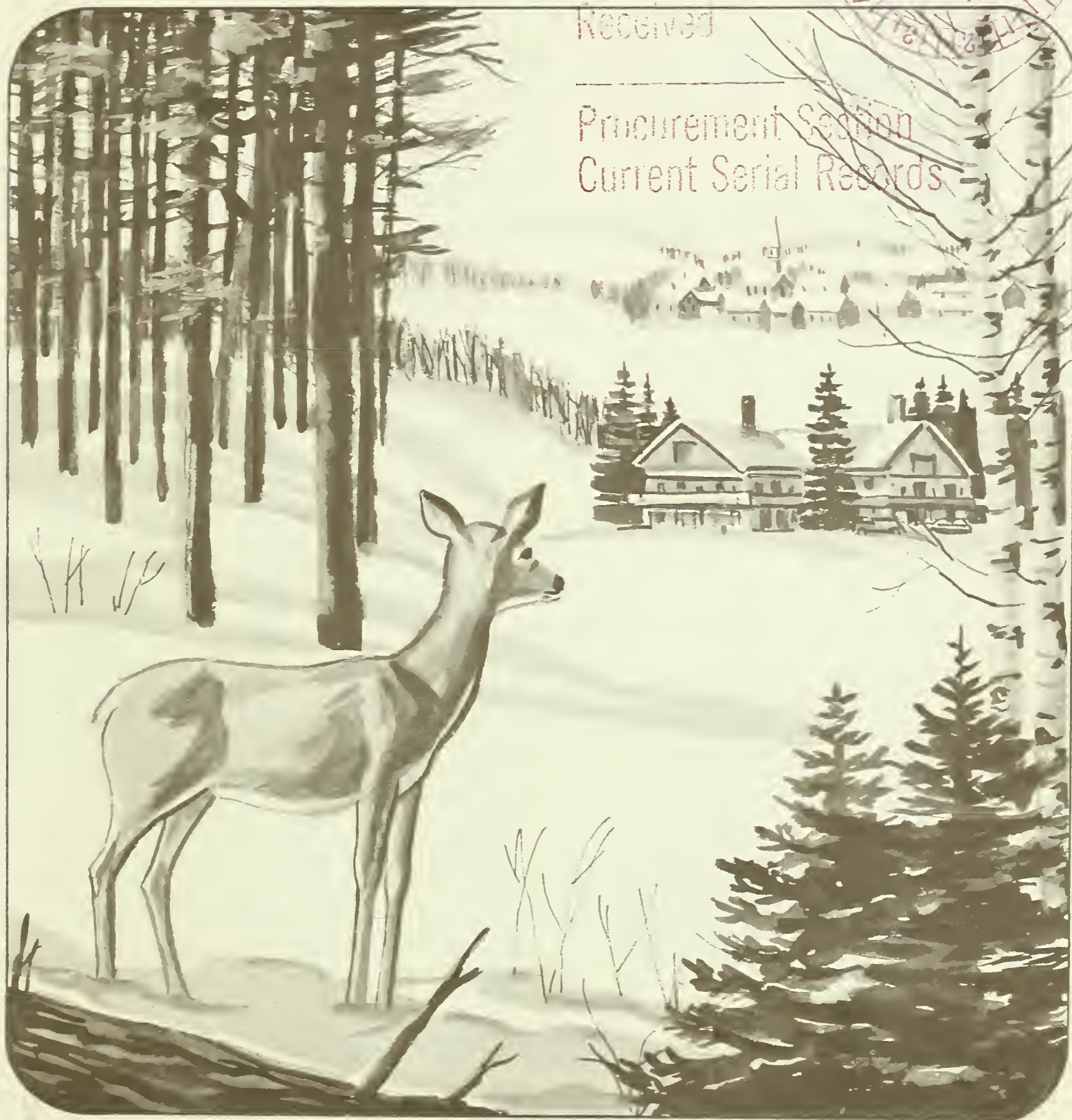
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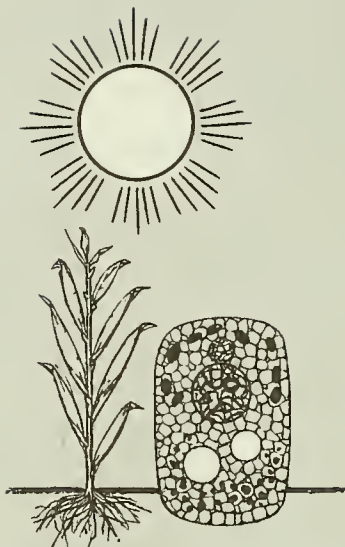
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AGRICULTURAL SCIENCE REVIEW

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A Way of Life

From the early days of our republic until at least the 1930's, no one would likely dispute the assertion that farming was a way of life. Today, however, it seems fashionable to discard the early Jeffersonian dream and declare that farming is no longer a way of life, but rather just another business venture that happens to have a rural setting.

People who expound this newer philosophy may resent being labelled iconoclasts, and perhaps they are right—in certain respects. But we can't help noticing that those who like to dispel this "aura" either never lived on a farm or are so far removed from their earlier farm environment that they are somewhat out of touch with reality.

Indeed, there is a fair amount of evidence to support the assumption that farming is still very much a way of life. Compare, for instance, the total investment and net income of a typical farmer.

Recently, the Nebraska Agricultural Experiment Station published the results of an eye-opening economic study showing just how much capital a young man needed to control in order to realize \$14,000 to \$16,000 a year for his labor and management on a Nebraska farm.

This study showed that the capital needs would range from \$250,000 for a 480-acre swine-corn farm in eastern Nebraska to \$1,765,000 for a 22,000-acre cow-calf ranch in northern Nebraska. That much just to earn an income of about \$15,000? The agrarian tradition just has to be part of a young man's philosophy if he makes this choice.

How does a young couple assume ownership of an economic unit this size under present credit policies? Says the Nebraska study: Only with substantial family help and cooperation. And therein lies the whole sum and substance of this whole issue—the close ties of family, nurtured by generation after generation of regarding farming as a most desirable way of life.

For more evidence, let's shift the scene a bit—to a banquet hall in Sioux Falls, S. Dak., on the night of March 5, 1972. The occasion was the annual U.S. Jaycees Outstanding Young Farmer Awards Dinner. Any outsider breaking bread with the group that night couldn't help being impressed with the

(Continued on page 31)

MAN AND WILDLIFE IN THE MODERN NORTHEASTERN LANDSCAPE



JOSEPH S. LARSON

TWO forces that mold the landscape are converging in New England today.

The first, termed *succession* by plant ecologists, is characterized most visibly by the return of forest vegetation to land formerly cleared for farm and pasture. Miles of stone walls among pines and hardwoods mark man's retreat from land unsuited to row and forage crops. By 1850 one-half of New Hampshire had been stripped of forest growth; in Massachusetts, forests covered barely one-quarter of the State. Today 85 percent of New Hampshire and 65 percent of Massachusetts are in forest. Although the degree of change in other New England States may differ somewhat, the overall trend is similar.

The second force is *man*, returning again to make different demands of the same land which his agrarian predecessors had abandoned to natural forces. In contrast to the earlier pattern of small villages surrounded by rural homesteads, modern towns ringing metropolitan areas are bedroom adjuncts of the city. Where once cropland was an integral part of a rural home, today a 1-acre plot or less is often all that is associated with its modern counterpart. Between the metropolitan bedroom complexes lie extensive areas of second growth forest rising 30 to 40 feet over old stone walls.

Modern highways and a desire to escape the con-

gestion of the cities have made many of these lands attractive to people who want to fit their homes into the forest community. Larger lots and cluster developments encircled by common lands kept in their natural state are an increasingly common pattern here. Such an environment holds much attraction for those who seek in some way to make their living quarters compatible with the forest and wildlife.

The Wildlife Build-Up

IN the wake of forest succession, many wild animal species, once extirpated or markedly reduced in numbers during the agrarian phase of the late 1700's and early 1800's, have returned in force. Among these are white-tailed deer, bobcat, beaver, black bear, and porcupine.

Deer, practically gone from Rhode Island, Connecticut, and Massachusetts by the early 1800's and greatly reduced in northern New England, have increased in numbers to support legal annual harvests in the 1950's averaging 8,000 in New Hampshire and 3,000 in Massachusetts.

Bobcat, once much reduced by land clearing, is now commonly found in wooded and rocky countryside.

Beaver, mainstay of a fur trade which peaked prior to the Revolution, were extirpated from most

of New England by the mid-1850's. Natural movement plus stocking and transplants of nuisance beaver have spread the species over much of its former range. In 1972 the Massachusetts beaver season will be extended from 2½ to 3½ months, mainly in response to landowner complaints.

Black bear, when their population levels were lowest, retreated to the most remote areas of northern Vermont, New Hampshire, and Maine and until recent years were bountied and treated as an enemy. Nonetheless, their numbers now support an annual harvest of over 300 in Vermont and they have penetrated well into west-central Massachusetts, which has never had a closed season on this species.

Changes in porcupine numbers are not documented, but their nuisance impact has grown with the return of forest and extensive efforts were made in the late 1950's to reduce their numbers by poisoning on large forested tracts in Vermont.

In contrast to its status in the colonial period, wildlife is now a managed, protected resource, recognized as having both tangible and aesthetic values.

In an urbanizing forest landscape, however, wild species are often a mixed blessing.

Beaver, hailed on their return to Massachusetts, were given total protection in 1932 and generated their first nuisance complaint only 2 years later, when their dams elevated the temperature of a stream used to cool milk. Relatively low fur prices have favored an increase in numbers and today there is virtually no location in Massachusetts where live-trapped nuisance beaver can be released without eventually causing plugged culverts or flooded fields.

Black bears passing near school bus stops generate frantic telephone calls from anxious mothers. Porcupines damage vacation homes and injure unwary dogs. The presence of deer hunters may be a difficult adjustment for the transplanted city dweller with his new home on the fringe of a watershed forest, particularly if he has also acquired a riding horse.

Normal regulation of wild animal numbers by trapping or hunting often encounters special problems in areas where homes, roads, and wildlife habitat merge. But this same environment contains the



songbirds, shrubs, trees, and small mammals the urban dweller now seeks to have about him. If man is to design his environment in harmony with existing natural factors and consciously plan the landscape to favor native birds over starlings and house sparrows, he must first acquire more information about wildlife as it relates to the urban environment.

The Search for Criteria

THE philosophy of fitting man's habitation into the natural environment is not new. Frank Lloyd Wright gave expression to this theme decades ago, and in the Northeast his "Falling Water" house in Bear Run, Pennsylvania is a striking example. In recent years, however, landscape planners have turned to the results of research to find scientific criteria for guidance. Soil maps prepared by the USDA Soil Conservation Service in the northeast stress interpretations of soils which identify suitability for septic tanks, athletic fields, sewer construction, and the like. Geologists are increasingly involved in mapping with an eye to potential groundwater sources for well-defined potential users. Probably the most eloquent exponent of the present effort to design communities within ecological constraints is Ian McHarg and his associates in Philadelphia (7).¹

In response to the challenge of the urban environment some agencies, researchers, and universities are initiating new programs and shifting the emphasis of others. The 1968 symposium "Man and Nature in the City" held by the U.S. Department of the Interior in Washington, D.C., and the 1970 symposium "Trees and Forests in an Urbanizing Environment" held at the University of Massachusetts, Amherst, document beginning efforts to identify problem areas and potential research avenues (1, 6). Woolfenden and Rohwer's study (10) of breeding birds in a Florida suburb, Hooper and Crawford's work (4) on bird distribution and habitat components, and Hilden's review (3) of habitat selections among European birds are important references for a review of this subject.

The U.S. Forest Service in 1971 established the Pinchot Institute for Environmental Forestry Research. One branch of the Institute consists of a consortium of nine public and private universities in the northeast. These institutions plan and con-

duct in-depth research, with Forest Service support, across a broad spectrum of topics, including urban wildlife. The other branch consists of two Forest Service research stations, one located on the campus of the University of Massachusetts, Amherst, and the other near Princeton University in New Jersey. These represent the in-house Forest Service effort and wildlife studies are centered at the University of Massachusetts unit (8).

Wildlife as an Amenity

WILDLIFE as a managed environmental amenity is a relatively new concept. Historically, wildlife management and research in and near urban communities has simply meant control of undesirable species, while in the countryside it has involved both control of crop damage and production of an annual population surplus for recreational hunting. Today's new planned communities create a third culture challenging the wildlife biologist. His traditional control and product-consumer experience is inadequate. On the other hand, the constraints inherent in these traditional approaches are removed and he is free to put prime emphasis, without apology or contrivance, on aesthetic values (5).

Specific studies by the U.S. Forest Service at its Amherst unit focus on humans, wildlife and their interaction. Implicit in this research program is the concept that there is a point in man's alteration of the landscape beyond which imported and often less desirable species have an ecological advantage over the more attractive and sought after native species, especially birds. In more simple terms, urban wildlife research seeks to find out what species are considered desirable and to identify the important variables in the environment which attract or repel given species.

A pilot study to determine human preferences and attitudes toward wildlife species in a small town is nearing completion. This is a forerunner for a more extensive study soon to start on several major northeastern cities and suburbs. Studies such as these seek to determine, on the human side, which are the preferred wildlife species, and how willing people are to manage for them about their homes. For the wildlife component, they seek to determine the requirements of the preferred species and how these may be provided. They also identify locales which already have desirable man-wildlife interac-

¹ Italic numbers in parentheses refer to Literature Cited, p. 6.

tions and how they may be replicated elsewhere.

One study jointly financed by the Forest Service unit, McIntire-Stennis funds, and the State is measuring, by time-lapse aerial photography, the impact man has made in the Massachusetts landscape in the 20 year period between 1951 and 1971. A cover map of land use and vegetation prepared from 1:20,000 photography in 1951 is to be compared with a similar one based on 1971 photos. The entire State is covered and the smallest land units identified are somewhat less than 10 acres. Open spaces within cities are also being examined as potential wildlife habitat and increased opportunity for man-animal interaction. The 1971 aerial photography is being used to identify cemeteries and abandoned rights of way within parts of the Metropolitan Boston area. Recommendations for cemetery and right-of-way management for enhanced song bird habitat are expected to result from this study. Segments of several of these Forest Service studies are also being conducted at West Virginia University, Pennsylvania State University and the University of Delaware.

Individual researchers have also turned to meet the suburban wildlife challenge. In 1967 the North American Wildlife and Natural Resource Conference for the first time included a technical session for wildlife papers with an urban focus (9). The U.S. Department of Agriculture's Cooperative State Research Service is supporting urban wildlife research studies in Delaware, Pennsylvania, and Massachusetts under McIntire-Stennis funds.

In Delaware, studies have been conducted on the impact of wooded parkland management on bird populations (2). Woodlands managed as parklands, cleared of brush, planted to grass and heavily used by people were contrasted with two forested areas with a natural understory and receiving moderate use by people. Periodic bird censuses and nest searches showed more bird territories, less nest destruction, and greater species diversity in the areas where the natural understory remained. At Pennsylvania State University, an urban wildlife study is aimed at the bionomics of pest and non-pest spe-

cies, contrasting animal life in a planned community with that of other communities. The goal here is to design pest species out and desirable species in the urban environment.

Interaction Problems

IN my own studies in Massachusetts, we are examining black bear and beaver as returning species which present special man-wildlife interaction problems. Sightings of bear in the State have increased in recent years, and concerned citizens have pressed to close the bear season to save what they erroneously thought were "the last bears in Massachusetts." Others have distinctly different impressions regarding bears. A public hearing led to a cooperative State, university and USDA research project to describe the history and present status of black bear in New England. Documentation of the spread of bears in recent years may help predict future movements and prepare the way for advanced management rather than belated reaction.

Beaver create and maintain their own environment. This behavior, when imposed upon a densely populated State, causes a host of complaints. The pelt price is no longer high enough to encourage adequate trapping, and a fairly large segment of the public has a protective attitude toward this romantic species. Clearly, one approach to this animal is to obtain a better understanding of its behavior, especially that related to dam and pond construction. Knowing how the labor is divided and something of what holds the colony together and regulates the distribution of beaver should lead towards a more selective control mechanism. Our studies indicate that the adult female is the dominant individual in many social and construction activities. Coupling this kind of evidence with more work on scent and sound communication will suggest potential selective management tools more acceptable than dynamiting dams and nonselective trapping.

The challenge of man and wildlife in the urban forest is not restricted to Federal agencies and individual university researchers. It is symptomatic of a broad challenge to the traditional role of north-

Photographs on the opposite page of the classic *Harvard Forest Models* depict the progressive change in the New England landscape from 1830, when cultivation and land clearing were at a peak, to 1930 when volunteer mixed hardwood stands of cordwood size had taken over much of the cleared areas.



1830



1915



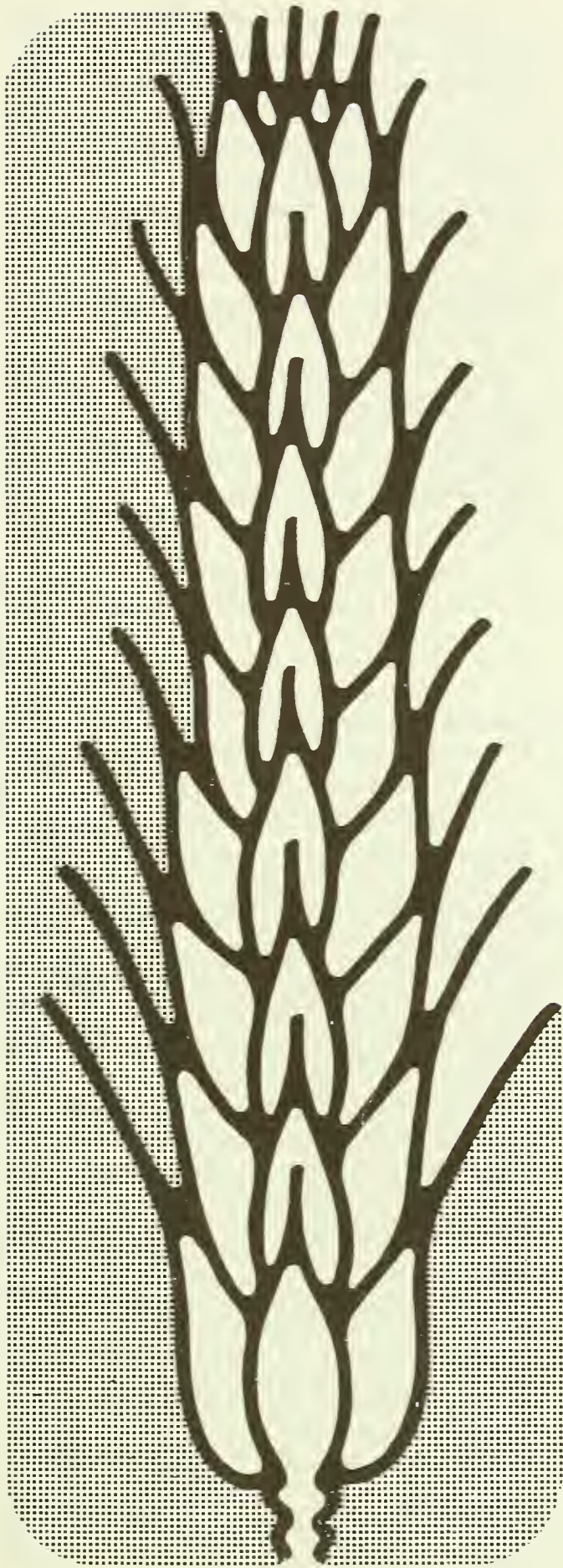
1930

eastern colleges of agriculture. Product agriculture here has declined in the face of an expanding population and great emphasis is now being placed on northeastern woodlands as home and recreation areas. The faculties of landscape architecture, resource planning, forestry, wildlife, and resource economics must play a leading and broader environmental role if the colleges are to recapture their status in pioneering and innovation education and

service. McHarg (7) has challenged us to design our environment with natural constraints in mind. This task is similar to that which the agriculture colleges and extension agents effectively met in the early part of this century. The trinity of instruction, research and extension, if turned to the new task, can be highly effective toward integrating man and wildlife in the urban forest environment of the Northeast.

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HYBRID WHEAT

A Review of Its Status and Prospects

LOUIS P. REITZ AND KARL A. LUCKEN

THREE years ago *Review* published an article on the history and food potential of hybrid wheat (Vol. 7 No. 3, 1969) as viewed by Dr. Norman Borlaug and his associates at the International Maize and Wheat Improvement Center, Mexico. It was a quietly optimistic piece, yet it left no doubt as to the complexity of the hybrid wheat research problems still unsolved.

Has the situation changed any since 1969? To find out, *REVIEW* interviewed two of the leading wheat research specialists in the United States—one at the Federal level, Dr. Louis P. Reitz of USDA, and one at the State level, Dr. Karl A. Lucken of North Dakota State University. Being separated by 1,000 miles or so of mountain and prairie, these two scientists did not have the opportunity to engage in on-the-spot colloquy as our two corn blight authors did in an earlier article. However, each was asked to react to the other's statements—not in an attempt to provide unity of thought, but to introduce an interplay of thinking and perhaps thereby round out the subject to its full deserved scope.

FROM a broad viewpoint, what is the status of the hybrid wheat situation today?

Dr. Reitz: If I may use an analogy, I think what we have today in hybrid wheat is a situation much like the early-day automobile, which was a buggy with an engine. The early auto worked; hybrid wheat works also. But sometimes Old Dobbin pulling the buggy in a race crossed the finish line first.

We have taken wheat varieties bred to be internally balanced and productive even though inbred, and have added the sterility mechanism. I believe we will have to do more than this to make hybrid wheat successful. We have had "converted buggies" to evaluate in our yield trials. We have done very little on yield genes peculiarly adapted to work in hybrid combinations. Maybe there aren't any such genes. However, a little development of this sort is being done, perhaps unconsciously, in the choice of the more suitable parental traditional stocks. But at a later time, if the mechanism is perfected and sterility and fertility restoration made constant, then the mechanism would be ready to be utilized in a more varied manner with variety stocks bred particularly to fit into this system.

Dr. Lucken: I think it is well to keep in mind that, up until the present, hybrid wheat programs still have not really been hybrid breeding programs in the sense that they are evaluating hybrids or the yield increases possible from hybrids. Of course hybrids have been produced by hand and tested in small plots and some A-line/R-line hybrids have been produced by using limited numbers of inferior males—both for fertility restoration potential and agronomic characteristics. But because of the technique or germplasm limitations, one must be very careful and skeptical in evaluating these data—whether they are positive or negative.

To get the problem narrowed down, which is more difficult—achieving adequate fertility restoration or devising an efficient cross-pollination system that will lead to economically feasible seed production?

Lucken: Our original concepts for breeding restorer lines were strongly influenced by experience with corn and sorghum. Breeders began backcrossing genes from the only two sources of restoration available into their wheat varieties; almost everyone met with less than satisfactory success. Now we have

broadened the germplasm base by using additional sources of restoration and cytoplasm and have evolved our own unique breeding procedures. Several alternative solutions have been found. And once a few good agronomic restorer lines are developed, subsequent breeding becomes easier.

More uncertainty exists for seed production. I doubt that the floral characteristics of most regular spring wheat varieties would allow economical levels of cross-pollination. But we are, with surprising effectiveness, shifting normally self-pollinated wheat toward a more open flowering habit in our parental stocks. However, whether or not the flowering characteristics can be changed sufficiently to obtain consistently high levels of cross-pollination, even under somewhat adverse conditions, is still an open question.

What are some of the critical problems in the production phase of producing hybrid wheat seed?

Reitz: The distance between the pollinator line and male sterile line is very critical. Naturally, the highest amount of seed set will come by having the plants standing side by side—in rows one foot apart, or with the heads interlaced so that the pollen falls only a few centimeters or inches to reach the stigmas.

That would be ideal as far as the spacing is concerned, but it's not practical unless you are going to market a mixed hybrid—that is, partly hybrid and partly self-pollinated. This has been thought of as a way to circumvent the difficulty. But we think in terms of drill strips of varying widths in which you would drill a strip of the male sterile, and then a strip of the fertility-restorer line beside it. These could be harvested separately by either going through the fields twice with a combine or using two combines to harvest the whole thing strip by strip, in which one combine would be harvesting the hybrid seed and the other the restorer seed. There has been quite a little research done on this—studying the effect of direction of wind on how to place the strips and how wide they should be, also on the number of feet of width that the drill strips might be to accomplish an ideal seed set.

Lucken: If we can definitely establish that hybrids yield significantly more than conventional varieties, a strong incentive then is provided for additional production research. At this point, seed producers and engineers probably could contribute more cost-

saving innovations than the breeder. Areas that need study are: special equipment for harvesting and processing hybrid seed; optimum planting arrangements; blend production (planting a mixture involving a high ratio of male sterile to restorer seed and harvesting the resulting hybrid seed plus a small amount of restorer seed); and marketing and sales procedures.

Then what you are striving for is a practical paying percentage of seed set?

Reitz: Yes, you have to balance off the cost of running machines through the fields versus a lower percentage of seed set. In other words it might be better to have strips 30 feet wide and settle for 75 percent seed set, rather than have strips 5 feet wide and strive for a 90 percent seed set. Of course, it would be much more practical to have wider strips, but this has to be worked out and balanced off against the total amount of seed needed and the cost.

Since the process of achieving a hybrid wheat is so terribly complicated and delicate, is there much danger of introducing other problems such as greater susceptibility to diseases and other hazards?

Reitz: One of the problems in our fertility restoration studies is to make this restoration stable over a wide range of environments—day lengths, temperature ranges, and the like. If it is so sensitive that a slight change of temperature would cut down the seed set appreciably, then this would be hazardous for seedsmen to produce and would increase their cost. Such sensitivity might carry over into the restored crop. Then the farmer might raise a sterile crop and this would be useful mainly for hay or pasture rather than grain. So we are trying to overcome that sensitivity just from the sheer standpoint of yield per acre, productivity, and stability of production.

But there are some associated difficulties with low seed set—one of these is ergot. The life history of the ergot fungus disease is such that when the flowers remain open and unpollinated for any extended period of time, they are open to the invasion of ergot fungus. If the flowers bloom on a normal schedule, become pollinated and close again, which is their usual way to behave, then the time for ergot infection is reduced. This is one problem that we see.

Now in respect to some other diseases, actually we see a big advantage in hybrids because once you have a good bank of hybrid seed germ plasm, you could overcome the appearance of a new race of rust in a matter of 2 or 3 years. In other words, about as fast as you could go into production with a new combination you could counter this new race of rust which might show up. With the traditional varieties, however, it might take from 5 to 15 generations to accomplish the same thing. This is the big advantage we see in hybrids—almost instantaneous conversion to another resistant type. You have to get ready for this. It takes a lot of planning, a lot of research, and considerable forethought by the research departments to build up a useful bank of breeding stocks peculiarly formulated to fit the hybrid system.

Lucken: Another aspect that must be recognized is that hybrids do not diminish at all the need for conventional breeding programs. These programs provide the parental stocks upon which hybrids must be based. But, theoretically, the value of these parental stocks should be amplified in their hybrids. Hybrid combinations can be planned so as to complement and overcome parental faults, including those involving disease resistance. In fact, obtaining the knowledge and understanding to predict good hybrid combinations will be the major activity of future hybrid work.

One or two procedures have been proposed, using hybrids, that might buffer a wheat cultivar against stem rust. However, exactly what effect hybrids would have on the composition of pathogen populations is a complex question to generalize on.

Also, some disease problems intensify. The male steriles in hybrid seed production fields are very vulnerable to loose smut and fusarium. I think Dr. Reitz is correct on his prediction about ergot. The chances are high that it will be the number 1 production problem in the Northern Great Plains.

What is your appraisal of the chemical method of making a wheat plant male sterile? Does it show much promise? Is it likely to replace the cytoplasmic system?

Lucken: Many of us doubted that any chemical could selectively cause complete or near-complete male sterility in wheat without affecting female fertility. During the past 2 years, P. L. Rowell and

D. G. Miller at Washington State have demonstrated that it may be possible. This summer, several programs likely will evaluate Ethrel¹ and other chemicals and attempt to optimize application procedures for their particular areas.

Both the gametocide and cytoplasmic systems have advantages and disadvantages. With the cytoplasmic system, the male sterile must be increased in isolation to obtain enough seed for planting hybrid seed production fields. This increases the time and cost factors; also, maintaining seed purity has been a major problem. The disadvantage with a gametocide is that it must be applied carefully and successfully during the early to mid-boot stage to

¹ Trade names are used in this publication solely for the purpose of providing specific information. Mention of trade names does not constitute guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement of other products not mentioned.

alternate drill strips on a relatively large acreage of seed production fields, inclement weather or not. Blend production would be difficult with a gametocide. A gametocide does allow direct use of regular wheat varieties for hybrid production. This factor is more significant to programs that haven't developed restorer lines than to those that have.

It's nice to have a choice. Time will tell which system is best.

Reitz: In this general area of research with gametocides, I think we must weigh heavily both the advantages and disadvantages. On the plus side is the fact that it completely bypasses the tedious process of developing male-sterile lines, and thus eliminates the need to develop fertility restorer lines. Obviously, this system also eliminates the need for two separate fields of the female line.



But on the other hand, chemicals have some disadvantages as growth regulators, because they may stunt the plants, and, if not properly applied, they may burn the leaves and make the plant unthrifty. But I expect these are problems that can be overcome as we study the process more, learn more about timing, or find other chemicals or different analogs to use.

I might mention also that this chemical method might be used in reverse—that is, to make the male sterile lines fertile on command. In other words, we could continue with sterile lines and reproduce them when desired by a chemical spray to make them fertile. We don't have such a chemical yet, but in my opinion it's within the realm of possibility.

But you do think this research is worth continuing?

Reitz: Definitely yes. It would solve a lot of the immediate problems that we're now facing in fertility restoration and in the seed set. The price of hybrid seed might still be pretty high, but the dependability of the product would be every bit as good as our best traditional varieties. And we cannot say that for the male-sterile cytoplasm system. It would be a great boon for the hybrid wheat potential.

If a chemical were developed to the point where we could use it economically, does this mean that all the other research on hybrid wheat would go down the drain?

Reitz: Not exactly, because this other research has pointed to desirable cross combinations and how to study these cross combinations. I suppose the development of traditional male-sterile lines would probably be discontinued if the chemical were highly successful—and in this sense our efforts would go down the drain. But in terms of the information obtained having been a wasted effort—this certainly would not be the case. It would still be useful information.

Lucken: Many restorer lines have unusually large anthers and high anther extrusion. These characteristics are associated with restorer gene blocks or have resulted from selection and are necessary and valuable for both methods of producing hybrids.

Has the hybrid wheat research program encompassed all the different kinds of wheat?

Reitz: Most of the activity has been done with hard red winter wheat and hard red spring wheat. There has been considerable work done with white wheat adapted to New York and Michigan and the hard and soft white wheats in the Pacific northwest.

Lucken: In North Dakota we presently are working almost entirely with hard red spring wheats. Our research with durum is mainly concerned with establishing the various genetic systems.

A few U.S. commercial seed companies are doing the bulk of the world's hybrid wheat breeding. They are directing proportionately more resources toward developing hard red winter types than toward other classes. The reasons are several. The acreage and, therefore, the market, are both larger. There are fewer problems with fertility restoration and hybrid seed production with winter wheats than with spring wheats. The economics of hybrids, both in terms of producing hybrid seed and dollar return from hybrids, are most favorable for areas with high, stable yields. This includes substantial acreage in the winter wheat states.

Hard red spring wheat probably ranks second in total effort, but there are significant programs for almost all wheat classes.

On a worldwide scale, many wheat breeding programs have adopted a wait-and-see attitude toward hybrids. For example, Canada and Australia have initiated very little hybrid wheat research. On the other hand, the Russians and Eastern Europeans evidence a fair amount of interest and activity in their publications.

Reitz: I think we ought to acknowledge, at this point, the very important role of the private seed companies in our nationwide efforts to produce a successful hybrid wheat. They have hired good people—trained plant breeders and geneticists—and have devoted real scientific effort to the problems. Simultaneously, they have tried to go into the economic problems and seed production problems to be ready to utilize what the research departments have brought out. At our workers conferences when hybrid wheat has been discussed, the people from the commercial companies not only come to listen but make significant contributions to the information that is shared.

Are we likely to have any protein problems with hybrid wheats?

Reitz: Yes, there is a possibility of change both ways. Higher yields would tend to depress average protein content of the grain. Of course in the classes of wheat used for pastry products, a lower protein content would be acceptable—even welcomed—by most segments of the trade. They like a lowered protein content, you see, because high protein tends to make the products tough and hard to chew. In contrast, high protein in bread wheats contributes to yeast action and is desirable. Some hybrid combinations have been high in protein content.

Is there any possibility that the genetic manipulations needed to produce hybrid wheat might change the traditional protein structure?

Reitz: Not the structure so much as the amount. We find the structure of protein in wheat pretty stable. There are differences but only in the way that protein is able to express itself rather than in the protein *per se*. Protein is very stable in wheat. By this manipulation I wouldn't expect that we would change the protein itself very much.

We have a general relationship between the yield of grain and protein so that when the yield goes up the protein percentage usually goes down. But this isn't always the case for two reasons.

Soil fertility management systems permit growing the crop to have a high yield and high protein, but this means that you have to manage nitrogen release and the nitrogen applications so that the plants have nitrogen to finish on. If they don't have nitrogen to finish the crop, the protein content will be low. But if the nitrogen is managed properly for this purpose, you can have a high protein in the wheat even though the yield is high.

Another factor is the genetic background in the wheat. We have wheats that have a genetic difference of 3 percentage points in protein. This gives the geneticist a considerable range of management in breeding the varieties. If he wants high protein, he breeds these genes into his wheat and keeps the protein at a high genetic potential. Then if he wants the opposite, he breeds those genes out, replaces them with low-protein genes to make the varieties tend to be low in protein. Then with nitrogen management, the protein content can be stabilized more or less—

not completely—because the weather has a great deal to do with protein.

We've had a surprise in some of the hybrid combinations—they've had higher protein than their parents—a sort of heterosis for protein—which is a nice thing to happen sometimes. We didn't expect this.

Lucken: On this matter of protein, I might mention here that, in our research with semidwarfs in North Dakota, our most serious problem is that they frequently have 1 to 2 percent lower grain protein and 1½ to 4 percent lower baking absorption compared to the conventional height varieties used as standards. Even with severe selection these deficiencies have proved difficult to overcome and only in the past year have semidwarfs with potential acceptability for these traits been identified among North Dakota breeding lines. An obscure picture of cause and effect relationships still exists as to whether high yield alone, the genes for semidwarfism themselves, the linkage group involving these genes or combinations of these factors cause the reduced protein and baking absorption.

The high protein content of some hybrids and restorer lines is possibly associated with the fertility restoration mechanism. We're now studying this in detail.

Can you draw any comparisons between the current hybrid wheat program and that of hybrid corn several decades ago?

Reitz: There are some similarities and, as you might expect, some aspects that are unique. The hybrid corn program, you may remember, at first progressed rather slowly over a 20-year period. Then things seemed to explode all at once and everyone started to grow hybrids. Truly good hybrids became available for the numerous adaptation zones and this was a great breakthrough. The great amount of publicity obviously helped to sell the idea of growing hybrids. There has been a fair amount of publicity about hybrid wheat too, but so far we haven't reached the point where we need to sell the idea. The popular press, particularly, I think, has sometimes led farmers to expect too much too soon. One contrast I noticed is that farmers today seem to be more aware of what is going on and perhaps more daring than they were during the pre-hybrid corn era.

To what extent have we benefitted from the knowledge gained in the hybrid corn research program?

Reitz: There was considerable benefit. For example, once we started research on developing hybrid sorghums, the breakthrough came much more rapidly and the industry converted in 6 to 10 years—whereas it took two decades or more in the case of corn.

Some carryover is apparent in our hybrid wheat breeding programs. For example, we know much more about genetics today—the manipulation of genes and that sort of thing. Yet the very nature of the wheat plant precludes any wholesale adoption of the techniques used so successfully with corn—particularly in the production of seed for planting.

Lucken: Corn breeding generally is ahead of other crops in methods and theory. Almost all corn breeding procedures involve extensive F_1 progeny tests. Sometimes I think the corn breeder's success is based not on hybrids but on the power provided by his ability to produce and test—simply— F_1 hybrids.

The ability to “yield test” hybrids could have a similar impact on wheat breeding methods.

Whenever a scientific breakthrough appears imminent and the public has been made aware that they can expect something, you scientists are often asked to speculate on a timetable. This has certainly been true with hybrid wheat. Have you had to change any of your timetables recently?

Reitz: Well, about 4 years ago I said that by 1970 we should know how hybrid wheat will perform and approximately how much the seed will cost. At that time our hybrid wheat development programs were progressing quite rapidly, and at least one commercial seed company was making several hundred bushels of seed available for pilot testing on farms. So at that time, it looked as if we were getting close.

As it turned out, by 1970, we found that hybrid wheat was not superior as earlier indications caused us to expect. So we found out that it wouldn't do as much as we had thought it would. We found very quickly the answer to the cost factor—that hybrid wheat simply wouldn't pay unless it out-yielded the traditional variety types. In other words, hybrid wheat wasn't good enough yet and the cost was too high.

The next logical question would be: What is the outlook now—in 1972?

Reitz: I think we are on a plateau, as far as I can see, in which the people who are working with hybrid wheat are trying to make the hybrid truly superior to traditional varieties. And in this period we see the traditional varieties being improved and this makes the standard to reach with hybrids all the higher. So we have a double thing going here, the inadequacies of the system to make hybrid seed are still with us and breeders are trying to find new genetic, chemical, or cytoplasmic systems to introduce into hybrid wheat so that it can be made cheaply and be a dependable high-producing crop.

This plateau that we are on now, is it likely to continue at the present level for any length of time?

Reitz: Yes it could continue at the present level for some time, because we are still making advances with traditional variety breeding so that the competition for hybrid wheat is going to be keener next year than it was last year. The standards then that the hybrid must reach are becoming higher all the time.

How do you assess the situation, Dr. Lucken?

Lucken: Before definite projections and predictions about hybrids can be made, we first must demonstrate conclusively significant yield advantages for hybrids. To my knowledge, this has not been done yet.

In essence, our research effort is really a major remodeling job on the wheat plant. Consider the changes—different cytoplasm, restorer gene blocks from several wild species and unadapted wheats, and altered flower characteristics. Besides that, it'll be hybrid.

In 10 years, genetic systems, depending on difficult, extensive gene introgression and transfer from their wild species and unadapted wheats, have been introduced into the major wheat classes. The extent and speed of these accomplishments probably are unequalled in any other crop plant.

We presently are improving the agronomic characteristics of parental stocks. This includes keeping and catching up with progress in regular breeding



programs. And stringent milling and baking quality requirements must be met.

The initial publicity on hybrids, and subsequent problems, has made breeders wary of timetables. I think two or three programs now have parents that conceivably could be used for commercial hybrids. These stocks of desirable parents should increase rapidly over the next 3 or 4 years and, consequently, increase the probability of producing a good hybrid.

I'd also like to point out that hybrid advantage is not simply a function of heterosis. Hybrid superiority is affected by three factors: (1) Breeding method efficiency, a rate-of-progress factor; (2) negative or positive effects of the cytoplasmic male sterility-fertility restoration used to produce the hybrid; and (3) the hybrid vigor inherent in wheat.

The point I wish to make is that it is difficult to make accurate assessments or even predictions about

hybrids until you are actually testing hybrids produced by an efficient, effective hybrid wheat program. Simulated studies, that is, hand-made hybrids, pollination studies using conventional varieties, give results that may or may not be valid. It frequently is difficult to tell.

If there is so much to be gained from developing a successful hybrid wheat, why are plant breeders still working with traditional lines? Wouldn't the payoff come quicker if there was more concentration on hybrids rather than this splintering-off of resources?

Reitz: It's true, of course, that by concentrating more on hybrid wheats we might expect to advance more rapidly. But you must remember that this kind of research takes a lot of new ideas. If you don't have a lot of new ideas to introduce and new materials to work with—more work on the same old things won't help very much. This is where the problem is. We need new ideas like the men in North Dakota are developing, like the chemical people have introduced. Actually there has been quite a concentration on hybrid wheat. If we had a way of assessing the man-hours of effort on hybrid wheat, I think it would be quite impressive.

Dr. Lucken, this seems like a good spot to mention some of the research highlights we've been hearing about from the North Dakota program. Could you give us a brief summary of the current status of your program?

Lucken: I'd be glad to. Most of our research has been on cytoplasmic male sterility and fertility restoration systems. We can produce—and have produced—completely fertile hybrids using several alternative stocks and methods. Some of these are supplements to the widely used *timopheevi* system and allow rather unique handling of breeding materials. But, with several apparent solutions, we still must decide which particular scheme is most compatible with efficient breeding.

At the same time, we've become increasingly aware that cytomplasms and restorer genes affect plant processes and characteristics other than male fertility. We know enough to understand how little we know. So these factors must be considered in our choice of systems.

Our results from field production studies are both favorable and unfavorable. Varieties differ greatly in cross-pollination potential. Early planting and environmental conditions that favor 35+ bushel/acre wheat yields generally give good results. Conversely, conditions which limit conventional wheat yields have an even more drastic effect on cross-pollination. In North Dakota, yield instability and ergot will be the major production problems.

As we begin testing hybrids, two observations make a strong impression. First, crossing block techniques allow us to readily produce many more hybrids than it is possible to test. But, second, outside of parental performance *per se*, we have almost no knowledge about which particular hybrid combinations should be tested.

The better hybrids grown in regular yield trials during 1971 yielded in the same range as the best experimental lines from the conventional program. These lines, incidentally, yield substantially more than Waldron, North Dakota's leading commercial variety. However, our first extensive look at hybrids will come this summer when we will test around 150 hybrids in regular yield trials. The male parents of these hybrids are fairly good agronomically—although still not comparable in yield to the best conventional lines. The data so far lead me to believe that yields of 10 percent or so better than the best varieties will be relatively easy to achieve. Whether yield increases of 20 to 30 percent are possible with hybrids, I simply do not know. And perhaps speculation isn't so important any more since over the next few years we will accumulate the actual data.

Coming back to this idea of a plateau that you mentioned earlier, Dr. Reitz, would you agree with Dr. Lucken that speculation isn't so important right now—at least until we accumulate more data?

Reitz: Yes, I would agree. And if I may review very briefly some of the history of hybrid wheat, I think it will be evident why this is true.

Heterosis in wheat until very recently was all based on hand emasculating traditional varieties and cross pollinating those again by hand and taking these few seeds and putting them in small plots—oftentimes as single plants and making the

determinations on that kind of material. Now in the first place, the spacing was not comparable to what you would get under normal agriculture and in the second place, the cytoplasmic male sterile system was not being used to make the seed. Therefore, we did not have the restoration problem in these crops from hand-pollinated seeds because there was no sterility to start with.

From this we saw a potential for hybrids on the order of 16 to 30 percent and this can get you very excited. Now when we use the male sterile cytoplasmic system, we may lose some of that in the failure of all flowers to be fertile. You can't lose very much until you have lost it all—all the advantage. We have come from no true hybrid wheat to test to a period where now, as Lucken says, we have materials in abundance made by these various systems. The real test will be whether these combinations will produce 10 percent, or 25 percent, or a favorable rate over regular variety types.

What is the attitude of farmers toward hybrid wheat?

Reitz: They're eager to learn more about it, and I think they would be quite ready to try hybrids once they are available. Of course they would want to be reasonably assured that switching to hybrid wheats would be to their advantage economically. I think it would be a mistake to offer hybrid seed prematurely, because if a field of wheat didn't produce as much as farmers had been led to expect, their attitude toward hybrid wheat would be somewhat skeptical, to say the least.

In view of all the time, money, and effort we've put into the hybrid wheat research program, would you say that, if we didn't realize our goal, all these investments would be wasted?

Reitz: No, indeed. This is what research is all about. You don't know when, if ever, research will be successful and pay off. This is what research really is. You're right on the cutting edge of new knowledge; you don't know what you will find out—whether it will be negative, useful, or revolutionary. There is a line from a poem that I recall—I don't know the author—but it ran like this:

“A well-worn path to the dump leads out from research.”

Let me cite some specific examples of negative research. We have many cases where we have tried to breed for resistance to certain diseases, but have failed because we could not find effective genetic resistance. That's one reason we still have ergot. We've looked for resistance, but have found very low levels of effectiveness. A few years ago we tried to breed a perennial wheat and this was a practical failure. Oh, we got some stocks that lived over 3 or 4 years; I've seen these. From one seeding you could harvest grain for 3 or 4 years from the same sowing, but this was a practical failure in terms of productivity.

So perennial wheat is one that you could say went by the board. However, some byproducts of this research have more than paid the cost. Until recently, the work with triticale has been a failure—a practical failure. Triticale has been known for 75 years, so you would have to say that triticale has been essentially a failure. Well, how long does it take to be successful? We think some of the present stocks are overcoming weaknesses that we have had in triticale before.

Could we sum up this colloquy, then, by concluding that both of you have considerable faith in the outcome of this revolutionary commercial venture on the wheat farms of America?

Lucken: Yes. Again I'd like to point out that important benefits already have been realized in our hybrid wheat programs. The Japanese, S. S. Maan, and others have identified 11 distinct cytoplasm plus numerous restorer genes among wheat relatives and incorporated them into bread wheats. The materials, perhaps the most extensive in higher

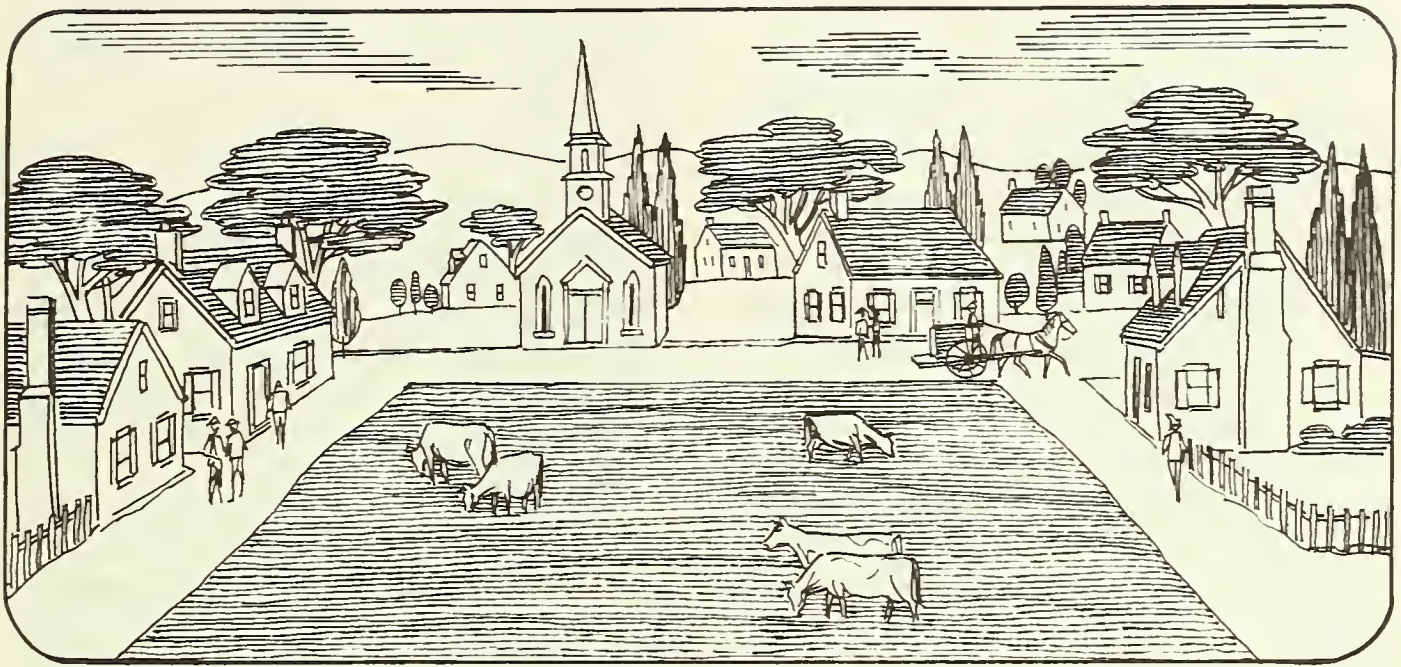
plants, are a foundation for studying the genetics of cytoplasmic variability. There are many exciting implications in this work. For example, new insights have been obtained from these genetic stocks into the evolution of wheat and its relatives.

Is there a better way to study and evaluate yield potential in wheat than through the use of hybrids? I don't think so.

The list could go on. Mainly, hybrid breeding provides a perspective of wheat somewhat different from that of conventional breeding. The new ideas and approaches stimulated may be an adequate justification for hybrid wheat.

Reitz: I feel that every penny that has been spent on hybrid wheat so far has been worth it, because we have learned so much about wheat in this process. We have found out things about the genetics of wheat, reproduction systems in wheat, and a lot of detail about how the wheat plant grows, disease control, and about problems that we may face in our traditional wheat. The sterility system and the chemical system have given us for the first time a means by which we can make massive cross combinations among hundreds of different lines of wheat. Before, a plant breeder was able to do only as much as his two hands could manipulate with a pair of tweezers. Now, by planting male sterile lines among a diverse collection of varieties, he can have hundreds or thousands of cross combinations brought into a breeding program all in 1 year. Before, this would have required a lifetime of research. As I view the situation, I think these and related benefits have justified the whole cost of hybrid wheat development to this point.

Thank you, gentlemen.



AGRICULTURAL STRATEGY IN THE TRAGEDY OF THE COMMONS

JAMES G. HORSFALL

IN working out strategy, one has to look ahead. Let us look forward to where agricultural science might go in the “years of the ecology.”

About 4 years ago Garrett Hardin wrote a very dramatic essay in *Science* magazine, titled “The Tragedy of the Commons.”¹ I prefer to call it “The Parable of the Commons.” As you may remember, in medieval Britain and colonial United States, every village had a commons. The most famous in this country, of course, was the Boston Commons. All New England villages had these, although they were generally called the village green rather than the commons. In those days, of course, almost everyone had to have a cow because there were no dairies; hence the villages created the commons as a place to pasture cows. Everyone had a right to pasture a cow on the commons. This system worked

fine as long as the village was small and the commons was big enough to support the cattle. The village population grew and the number of cattle increased until eventually there was insufficient space for all cattle to graze. This did not deter a new villager, however.

Let us suppose for the sake of discussion that the commons could support 100 cattle. Now when the 101st villager moved into the area, he proceeded to buy a cow and put her out to pasture on the commons—even though he might have known that the commons had reached its capacity and that there would not be enough grass to support all the cattle. The damage that his one cow would do, of course, would be only 1 percent of the total. This 1-percent damage, naturally, would be spread among all the villagers. He would pay only 1/100th of the damage

¹See “The Tragedy of the Commons” by Garrett Hardin, *Science* Vol. 162, December 13, 1968.

This article was adapted from an address which the author presented at a science seminar held at Beltsville, Md., December 2, 1971.

and the rest of the damage would be shared by the other villagers.

Sooner or later a drought struck and put the commons under stress. The cattle would give increasingly smaller amounts of milk and the children who depended on it for their sustenance would not have quite enough to drink. Eventually, under this plan, the commons would collapse.

The fundamental characteristic of this parable is the collision of two freedoms. Everyone had a right to put a cow on the commons, and everyone's children had a right to a supply of milk. The villagers had an infinite freedom, but they had only a finite commons. And this is where the tragedy of the commons began. The collision created friction among the villagers, and the village, they said, was going to pot.

A Modern Analog

TODAY'S analog of the commons—one of them at least—is air. Thus the cow becomes an automobile, and the commons becomes the air. Just as everyone had a right to put a cow on the commons, so, today, everyone has a right to put the exhaust from his car into the air.

This was all right back in the days of the Model-T, but the situation is quite different when our streets are choked with automobiles and an inversion occurs. Such an inversion hit the city of Birmingham recently. Then the air commons collapsed; trouble set in; and Birmingham shut down.

The problem is precisely the same as the villagers experienced with their cows. Everyone has a right to a clean environment, and everyone has a right to put a new car on the road. Today, these two freedoms are running head-on into each other. And therein is the tragedy of our commons. As I see it, the effects of this collision will worsen because the population is on a collision course with the environment.

You will remember an identical situation which Malthus described in his book in 1798. He said in effect that because the people of Britain had an infinite freedom to reproduce, and because the size of the commons was finite, eventually they would run out of food. It is interesting to note that Malthus was an islander. I doubt very much if he would have expounded that principle if he had lived deep in the heart of Texas. He could see that the size of Britain

was limited and that the expansion of population was unlimited. In his view, back in 1798, the end was in sight.

Emerging Role of Agricultural Science

WE in agriculture did something about this. We increased the carrying capacity of the commons. We made two blades of grass grow where only one grew before. Had we agricultural scientists been available back in the days of the commons, I would not have been able to tell you this story because we could have shown the villagers how to produce enough grass for their expanding needs.

Agriculturists know more about the environment and the problem of the commons, probably, than anyone else. We were in ecology a long time before ecology was a popular term. We have the historical background to deal with these problems. Let us examine our background in environmentology.

Of all men, farmers are closest to the environment. They do not live in an air-conditioned cocoon, as a city man does. Ancient farmers in the fertile Crescent of the Near East discovered a long time ago this over-exploitation principle of too many cows on the commons. The population of that part of the world went up, cities grew, demand on the land went up, and there wasn't enough land to go around. The droughts hit them and of course it was a dry country. The cities of Nineveh and Babylon and Troy died. It was no longer a land of milk and honey—a real tragedy of the commons.

The same thing happened to the Mayans on the Yucatan peninsula and to the Indians of Mesa Verde. And the farmers of Oklahoma, Texas, and Kansas in the thirties paid the same price. Their commons collapsed, and the societies collapsed with it. So over-exploitation has forced farmers to be environmentalists and agricultural scientists to become environmentologists.

In New England we began to see the collapse of the commons a hundred years or more ago. The land in New England is not very rich. It's a put-and-take sort of agriculture. If you don't put the nutrition into the soil, you don't get a crop out. And in those days we didn't know much about nutrition. It was quite clear, therefore, that something had to be done about it.

It is interesting to me that these gravel-land farmers of New England had such an enormous in-

fluence on agricultural policy in the United States. In 1847 Norton, in Connecticut, established the precursor of the Sheffield School at Yale and endowed it to set up some of the very first science devoted to agriculture. Morrow of Vermont set up the land grant colleges, and Ellsworth of Connecticut set up the Patent Office which subsequently became the Department of Agriculture. Newton of Pennsylvania and Delaware put the USDA together in 1862. Johnson, from the poor foothills of the Andirondacks, set up the very first agricultural experiment station in this country. Pinchot of Connecticut set up the Forest Service in the Department of Agriculture. These men were the precursors of our modern environmentology.

The Meaning of Agriculture

BEFORE I examine further the strategy that we deal with in the tragedy of the commons, let us consider one of our most serious weaknesses in our strategic position. It is a self-created weakness—a weakness that we have brought on ourselves without anyone's assistance. It is the feeling that exists in our universities and in other segments of agriculture that agriculture is a dirty word. You've heard it expressed, I'm sure, and so have I. It has distressed me for years.

A poker hand is what you call it, and if we say that agriculture is a dirty word—you know very well it's a dirty word. The odd thing is that we are the only people who call it a dirty word. This is what amazes me.

I think agriculture is beautiful. Agriculture provides the food for the Nation, and when people meet together and want to have a good time—they always have a banquet. No organization in America has its annual meeting without a banquet. It's the place where you enjoy getting together with your friends. Do we in agriculture use this in our public relations? No. I have never heard an agricultural speaker bear down on this point. Agriculture is the trademark of a jolly occasion—not a dirty word.

I happened to help write a book called "Environmental Policy for Connecticut." The committee involved many citizens of my State and one of these was Hal Borland, the man who writes those gorgeous nature editorials in the Sunday *New York Times*. This is what Borland, a city man, wrote for the section called "Food and Agriculture."

"Without food we starve, and without agriculture we would have to scrounge among the roots and rocks for sustenance.

"But 'Man doth not live by bread alone' and agriculture provides more than bread. Agriculture occupies two out of the three million acres in Connecticut. It covers our rolling countryside with forests, farms, and open spaces. Its red barns and silos, meadows and maize, lend interest for landscape painters to paint and for all to enjoy.

"Agriculture includes the wooded land, the suburban lawns, the flowers and trees, the rocky ridgetops, the lakes and rivers, the swamps, marshes, and shellfish grounds as well as our working farms.

"And so agriculture gives a sense of beauty and pleasure. It may be the pleasure of a beautiful view. It may be the satisfaction, a very special pleasure, of work accomplished on a farm or in a garden. It may be the satisfying taste of Connecticut fresh milk, of homegrown fruit, of sweet corn fresh from the summer field, of tomato's lush ripeness fresh from the vine. This we have known and cherished. Unless we decide wisely now, these pleasures and these satisfactions, these treasured values of our land, could and no doubt will vanish."

Borland thinks agriculture is beautiful.

It is interesting to me to examine how it was that agriculture became a dirty word. The English language has three words for food producers—farmers, husbandmen, and agriculturists. *Farmer* comes from the old French word, *ferme*—to rent or to lease—specifically land, and hence a farmer in the old French was a share cropper, a peasant, a serf.

Husbandman comes from Anglo-Saxon. You may recall that the Grangers of the country call themselves the "Patrons of Husbandry." *Husbandry* comes from the two Saxon words, *hus*—the house, and *buondi*—to dwell. So a husbandman came to mean a peasant or a serf, because he lived in the shack provided by the lord of the manor. The word *bondage* comes from the same root. In the Saxon days, a farmer was in bondage.

Agriculture on the other hand comes from the Latin *ager*—the field; and *culare*—to till or cultivate. *Culture* of course, is the state of being cultivated, the enlightenment and excellence of taste. *Agriculture*, therefore, is a beautiful word—in contra distinction to *husbandman* or *farmer*.

Well, how do the words *agriculture* and *farmer*

fare in modern thought? To make a friend, you cultivate him. To make a beautiful flower garden, you cultivate it; if it is beneath your dignity, you farm it out. The peasants in the New York Yankee system are called the farm clubs.

Intellectual agriculture in America did not start out as a dirty word. Johnson and Pinchot and the men I mentioned earlier came from well-to-do families. They were gentlemen farmers; they were concerned with agriculture. The experiment station in New Haven was set in business by a lawyer; he didn't look upon it as a dirty word. Morrill, in a superb performance, delivered us from bondage by helping us to abandon our Saxon heritage of bondage and serfdom. He helped us to assume the Latin heritage of agriculturists. To Morrill, agriculture unquestionably was a beautiful word just as Borland has described it. Morrill created agricultural colleges—not farm schools.

Let us hold up our heads. Let us consider that agriculturists are not serfs and peasants. We are not the farm club for the Yankees—we are the Yankees themselves.

The Agricultural Base

WHERE do we, the agriculturists, fit in the strategy of dealing with the tragedy of the modern commons? We have a vast base in agricultural science to build on. Crowding of men together is certainly one of the great environmental issues of the day. We in agriculture have been dealing with the crowding of organisms since we got into the science 100 years ago. We called it competition, of course. Competition in a species—that is sociology. But agronomists call it spacing research and this dates from the beginning of agronomy. The chicken men call it pecking order, and that introduced a whole new term into sociology. This is the competition between organisms in the same species, and we have a vast amount of data on it.

I think it is high time that we reexamine this 100 years or more of experience with crowding research that we have done so brilliantly. Let's reexamine it in terms of the modern life of the crowding of man, the crowding of the commons.

We know a lot about the crowding between the species also. I think we could use many of these data to write a monograph on crowding. Compe-

tition between species, we might call weed science; a plant pathologist calls it host-parasite relationships; the foresters call it succession. So we have a vast amount of data which I think we ought to bring to bear on the problem. This is the result of our environmentology research over all these years. Let us adapt it to man.

Next, consider some of the poisons that man throws into his environment and what we in agriculture have to offer in dealing with it. The plants and domestic animals that we grow can be the guinea pigs to test the substances. The lead problem in the ghetto is a specific example. We painted those old houses in the ghetto 40 years ago with lead paint, and then added more and more coats. Now, this paint is peeling off and the children in the ghetto, being a little bit off in nutrition, seem to like to eat the lead flakes, and they get lead poisoning which affects their nerve system and sometimes causes death. Medical specialists tell us that a child afflicted with lead poisoning excretes delta-aminolevulinic acid into his urine. We in agricultural science know about this acid, because it is one of the precursors in the biochemical synthesis of chlorophyll and red blood. At our place be decided to put this knowledge to work, therefore, in the problem of lead poisoning in the ghetto. Of course this is not agricultural research. But it's an area where we can bring agricultural know-how to bear on a very important problem in the ghetto.

At my experiment station in New Haven, the ghetto is only several hundred yards away. So perhaps we are most sensitive to such a problem than some other agricultural stations are. Taking this bit of medical data about the acid secretion, we decided that it might be detected in the urine with ion exchange resins, eluted, and measured to determine whether the child had lead poisoning. The system worked, and it is now widely used by State health agencies. This is an example of one area where we can apply our knowledge to a problem of the environment.

Ozone and nitric oxides in the air offer another example for the application of our unique knowledge. We can study the effect of these on our plants and our animals. Ozone affects the permeability of cells to water just the same with the cells of the lung as it does in the leaf cells of tobacco. We can investigate the mechanism of action of ozone.

Disposal Sinks

I want to consider now some of the sinks for the disposal of wastes of various kinds. There are four that we can deal with in agriculture—water, air, soil, and living organisms. Agriculture controls huge chunks of all of these sinks except air. How can we bring our technology to bear on these four sinks? Water and air were contaminated by man a long time before he contaminated soil. Air and water both move and they provide a very cheap system for getting rid of waste. We just dumped it in the water and let it go and the transport was provided gratis. The same thing is true of air.

In the case of soil you have to take the waste to the soil. Now, we are beginning to hear a lot about sanitary landfill and similar means of disposal. These two methods of dealing with wastes created a couple of aphorisms, the most important of which you have probably heard about—the solution to pollution is dilution. Now, however, since we can no longer pour our wastes into the air or into the water, I would like to create a new aphorism for that—namely, that the solution to pollution is now expensive. It is going to get very much more expensive and society will have to pay for it.

We have heard a lot about the water sink in recent years. "Lake Erie is dying," Barry Commoner says, "because the farmers have put too much phosphate and nitrates in the water." He overlooks detergents and sewage. We have had pollution in our Connecticut lakes as long as I can remember, and in attempt to understand the problem better we have been running nitrogen and phosphorus budgets on our lakes. The phosphorus in the lake is no different from phosphorus in soil and the nitrogen either as far as that goes. The soil sink has been used by man to bury his dead since the beginning of time.

Agronomists have to rotate about 180° in their thinking. They have struggled for years in trying to unbind the phosphorus from the soil. Now we want to go the other direction. They must bind it to remove it from water. Agronomists can work on the adaptation of soil survey to our city problems. In our State we have reworked our whole soil survey system in terms of how useful it is for septic tanks, disposal systems or drainage fields. Some soils work better than others, naturally. An ideal

plan might be to select a soil type so that a new development could be put in without using a sewage system. This is an area where an agricultural scientist can be very useful to a city man. Penn State, as you may know, has been pumping sewage and waste water into the forests, and over fields, and using soil as a filter. We are doing similar research in Connecticut.

Micro-organisms are sinks. I recently heard a geochemist tell an interesting story about the silver in Long Island Sound. He developed a silver budget. He examined the silver coming into Long Island Sound in the surface water from the east and compared it with the silver going out in the bottom water. Oddly, he discovered that less silver is going out than is coming in, in spite of the fact that photographic processing plants up and down the rivers are dumping a lot of silver-containing waste material into the water. By running a budget on silver, he found that a tremendous amount of silver was coming down the rivers, indicating that Long Island Sound is being fed a lot of silver—both from the open ocean and from the rivers flowing into it, and yet there is less silver going out than is coming in. So he dredged up the bottom and found the silver there. He expected that it would be adsorbed onto the surface of the soil particles in the bottom of Long Island Sound, but it is not. It occurs as silver sulfide. What happened is that the sulfate bacteria under the anaerobic conditions on the bottom of Long Island Sound are reducing the sulfates in the water and are secreting enough hydrogen sulphide to convert that silver to silver sulfide, which was probably the form it was in when originally mined. Thus the recycling is complete.

This discovery suggested to our people a possible explanation of the difference between lakes that fix phosphate and those that do not. We are investigating the possibility that sulfates in a nonfixing lake may be reduced to sulfide and fix the iron there which would otherwise fix the phosphate.

Let us consider the farmer's soil as a giant compost heap, which means that it is full of microbes. Here is an opportunity to deal with wastes as a giant compost heap. I suggested to some of the farmers in my State that they might make more money using the crops of microbes in their soil than they could by raising tobacco or corn on the same land. Cities must get rid of the organic refuse that they produce.

Chicago, as you may know, has already bought a large farm and is going to experiment with this idea, so I think that this is a possibility farmers might well examine to see if they might make more money out of their microbes *in* their soil than they could by raising green plants on *top* of the soil. We might use the knowledge that mushroom growers have developed for the degradation of cellulose thru the action of micro-organisms.

On this matter of decomposing cellulose, we've got to rotate 180° in our thinking. We have been trying all these years to protect our cellulosic materials from decomposition. Now we need to rotate 180° and follow the same biochemistry, except that we're going to try to get rid of the cellulose and lignins that we have worked so hard to save. So if we do a right-about face, we can make a significant contribution to the modern problems of waste disposal.

The soil microbiologists need to rotate 180° too. They spend all their time trying to hurry the nitrogen process on into nitrates so the plants can use it. Using the same processes, plus different organisms—the same principles of biochemistry—and reversing the order of thinking 180°, they might reduce the nitrogen and reduce it to N₂ and put it back in the air where it came from, and thereby complete the cycle. I think it is very important that we should do this, but it will mean a complete reversal in our manner of thinking. By keeping the nitrates out of our waters, the ecologists would not be able to criticize us.

The entomologists need to rotate 180° too. Let's use maggots to reduce manure instead of trying to get them out of it. It is interesting to note that you can take the smelliest chicken manure and feed it to these maggots and it will be converted to a non-smelling soil amendment. Of course, maggots make flies. I suggest we use a wingless mutant, sift out the pupae, feed them to chickens, and complete the cycle.

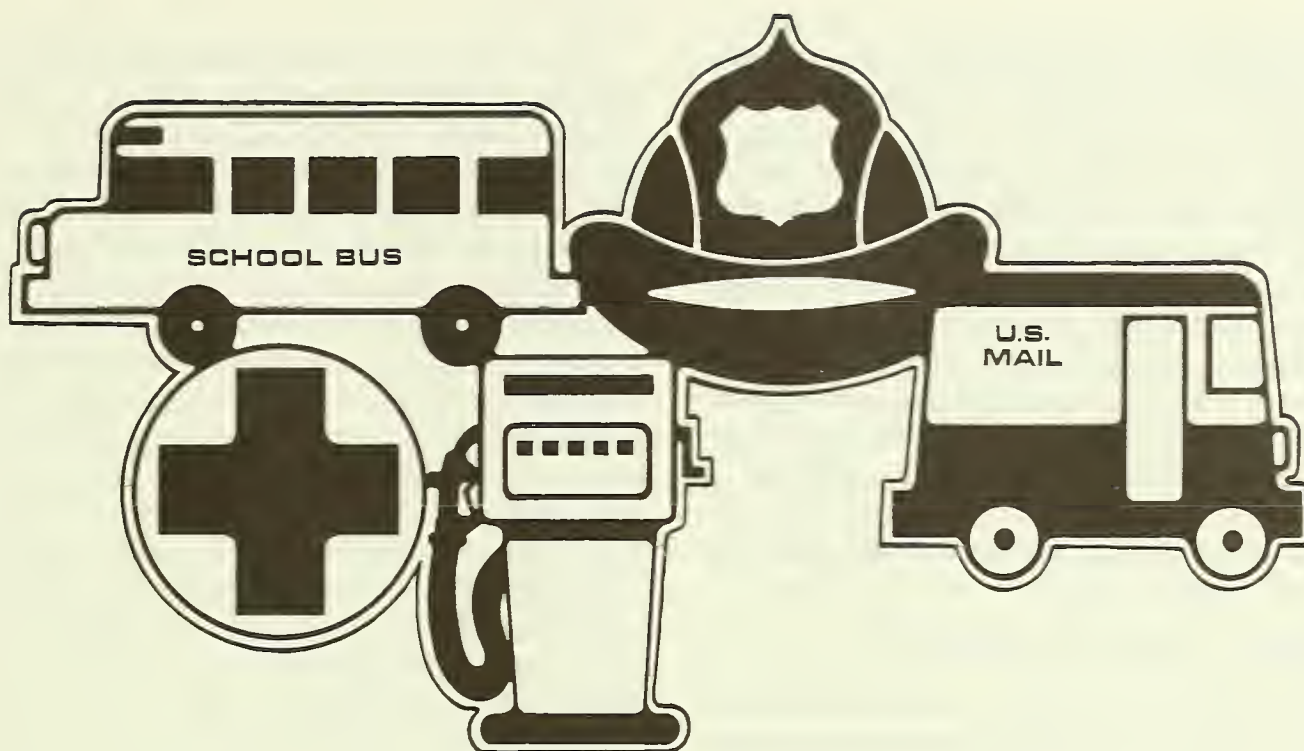
Plant pathologists need to rotate 180°. They spend a lot of time trying to inhibit the enzymes that rot potatoes; instead they might use these enzymes to destroy garbage. We made tests on this and discovered that these enzymes are very good garbage destroyers. But we had to rotate our thinking 180° to get to that stage. We must encourage the gulls, vultures and rats to eat garbage, and perhaps use activated carbon to get rid of the odors as we do to get pesticides out of the soil. There are many, many strategies that we can follow in dealing with the tragedy of the commons.

Finally, one point about green plants as sinks. Green plants have always removed carbon dioxide from the air. Now we are beginning to pay attention to removing such things as ozone and other pollutants from the air. We have calculated that 1 acre of green plants can take care of the CO₂ output from 50 commuters' cars. One acre of green foliage can remove the ozone output from eight cars. We don't know how much SO₂ they can take up, but this is being investigated.

We are also investigating the use of plants as sinks for noise pollution. They are pretty fair screens. We have investigated the shapes of leaves with respect to the way they reduce noise—hemlock vs. oak for example. There are some very interesting things that we can learn about the relation of shape and geometry of foliage to the reduction of noise.

The New Challenges

SO we are being handed the challenges. We have the know-how. We have been accepting these challenges from the agricultural and food industries for over a century. Here is a whole new set of challenges being given to us by people who are crowding the commons. I think we can make agricultural science useful to all of society, but we will have to shift our strategy in order to accomplish this goal.



TAXES AND FINANCING OF PUBLIC SERVICES

ALVIN T. M. LEE

THE rationale behind this article, appearing as it does in an agricultural journal, is more logical than one might first assume. Research in the State experiment station system is becoming increasingly concerned with sociological problems relating to the economic welfare of people both in rural and nonmetropolitan areas. Rising costs of public services—and means of financing them—are matters of particular concern to serious researchers. Within the past 12 months, public service projects have been approved and set up in all

four regions of the United States, and at least five States have obtained approval on Hatch projects dealing with social problems unique to the changing scene in rural America. At least two States—Arkansas and North Carolina—have established objectives closely paralleling the research goals which the author recognizes as being necessary to equitably relate public service benefits to taxing procedures. Dr. Lee's article serves as an extremely timely and informative background paper as these projects get underway—Ed.

AS society progresses in its capacity to provide greater affluence for an ever-increasing proportion of the population, many people are demand-

ing that more of their needs be provided by their government. Yet few problems that lawmakers deal with are as difficult as that of coming to grips with

the question of what programs and services the government should provide and what level of government—Federal, State, or local—should have the responsibility. A subsequent or corollary question is: How should the services be financed? Despite the current discussion and publicity about public education and the property tax, this should be thought of as a part of a larger problem involving the total system of public services and their financing.

As an approach to this larger problem, this paper suggests (1) processes for developing public service programs and their financing for effecting closer relationship of financing to benefits, and (2) areas of the tax structure system that sorely need further research in order to better achieve national, State, and local community goals.

Changing Patterns in Tax Demands

DURING the 18th and 19th centuries when the United States was largely oriented to agriculture and natural resources, real property was the main item of wealth and the chief source of income. Tax paying ability was then closely related to property ownership. Also, most public service needs were locally oriented and were not too demanding on tax income. The benefits from the use of public funds redounded largely to the local community. However, with the economic growth of the Nation in both wealth and complexity, visible property of the individual has become a less important factor in total wealth. Because of the increased mobility of the population, benefits from some local public expenditures are reaped by areas far removed from the geographic center of the original tax fund expenditures.

Ever increasing taxes and the inadequacy of the property tax to finance its traditional share of government costs have resulted in local governments—city and county—seeking more State aid, and the States, in turn, are looking to the Federal Government for additional financial aid. Even as taxes rise, all levels of government are facing the realization that the traditional mix of tax sources is inadequate. And because taxes on property are most closely associated with democracy at the local government level, city and county officials are the first to meet with citizen resistance. When local property taxes are low, inequities are often overlooked. But when taxes become high, the inequities take on major

proportions.

In the search for more tax dollars to provide the expanding demands on public goods and services, legislators have often selected sources that have little relationship to the objectives to be accomplished. Taxes collected on alcoholic beverages and cigarettes, for example, have little relationship to specific uses of these tax funds. They were originally thought to be justified because they might discourage use of these products. Likewise, parimutuel betting is in the “sin” group, and those who can afford to spend money this way, it is believed, can well afford to allot a portion of it as taxes for general purposes, since they probably would waste their money anyway. Recently a number of States have enacted State-managed lottery systems as means for providing needed additional tax revenue. Florida’s tax on dog racing is earmarked for use in helping to finance public education.

There are many other examples of taxes imposed upon special commodities and activities or special groups of people where the tax payment has no relationship to the public goods or services received by those paying the tax or those requiring corrective programs because of harmful effects from the use of these products. The disassociation of costs and benefits in our local, State and Federal tax systems has created a veritable jungle in the Nation’s tax structure. In devising tax laws and tax systems, there is a tendency to want to manipulate things so that some *other* groups or persons will pay the bill for those things we would like to have the Government provide.

Inadequacy of Property Tax Revenue

IN the early decades of the 1900’s, several of the essential public services were really subsidized by the people providing the service. Public school teaching is an outstanding example of a group working at low pay because it was looked upon as a temporary stepping-stone type of employment by many and as a temporary before-marriage job by others. Teaching also had a status value, and the experience was looked upon as self-improvement. Gradually, this occupation has changed to a permanent career type, and the extremely low salaries have been raised to provide a living wage and adequate family support. This change plus improvements in school facilities have been a major cause for the great in-

crease in property taxes which provide the main support for public education.

In a 6 to 1 decision, a California court recently headlined the relationship of the property tax to education when it held that heavy reliance on unequal property tax "makes the quality of a child's education a function of the wealth of his parents and neighbors" and thus, denies "equal protection under the 14th Amendment of the Constitution" (Serrano vs. Priest). The question has brought forth similar court decisions in other States and may well influence other court decisions across the Nation. These decisions will lead to greater State support for public education. The inequities will not be solved by these actions, however, since unequal financing among States will continue to exist and may be more important than unequal financing within a State. This seems to be overlooked in the present clamor for shifting school financing to the State.

A Rational System

THE Nation is at a point where major consideration needs to be given to bringing order into the tax structure and a rational allocation of public service responsibilities among local, State and Federal governments. It is necessary to consider the service needs and methods of financing concurrently so that a rational and responsible system may be developed. Developing public service needs and financing as a package would result in (1) a more rational division in the sharing of responsibility between public and private sectors, (2) a more realistic public service program insofar as quantity and quality are concerned, and (3) the development of a revenue source closely related to service needs. Citizens would then know that their tax dollars were being spent for the goods and services desired. Paying for public services with "easy money" creates an attitude of "give me more since I do not need to pay for it." This is the basic weakness with Federal and State aid, when administrative responsibility is not related to the funds distributed.

Relating Services to Incidence of Benefits

ONE way to approach the problem would be to classify the major public service needs, determine the incidence of benefits, relate them to whether they are of national, State or local concern and

the mix of this concern, and then determine the most rational way to finance the service. Where special problems are caused by certain activities, such as pollution of air or water, the cost of correction could well be financed by special tax levies on these activities or groups that engage in the activity.

The assignment of responsibility for administering and financing these services among the levels of government should be based primarily upon the incidence of the benefits, that is, the extent to which the benefits remain strictly in the local community where the public service is obtained or finally becomes diffused among communities far removed. Education is an example of the benefits redounding to communities far removed from the locality where the individual obtained his or her education. Thus, the community where the individual finally obtains employment is more affected by the individual's education than the community where he obtained it. The benefits from education are diffused nationwide. Likewise, the lack of an adequate education is a national loss. The Nation is concerned that every individual child receive a minimum level of education. Therefore financing a minimum level of education with a Federal tax would be the most logical method.

Water and sewer facilities are examples of services directly related to property; the benefits accrue entirely to the local community and have little or no carryover benefits to other communities. With such reasoning, one could rationalize that water and sewer facilities are a local responsibility—either individual or community, or a combination of these two. There are many instances, of course, where the social desirability of having certain services and goods justifies State and Federal action in providing program and institutional arrangements to help local communities do what will benefit the community as a whole.

Recent suggestions that increased taxes on the operation of automobiles (gasoline tax) be used for improving the total transportation system are logical. The automobile is in large part the cause of traffic congestion and air pollution, and the cost of corrective measures is a logical cost of operating the automobile, including buses and trucks.

Drug addiction, alcoholism, and, in some cases, emphysema, are problems caused by the use of specific products. Here again, it would be reason-

able to finance the research and corrective programs with funds obtained from a tax on the causative products. Use of such tax receipts on the needed corrective programs would be more logical than financing them from the general purpose fund. Taxing these products for the problems and costs they impose upon society is justifiable.

Welfare needs arise from causes originating largely beyond the boundaries of a local community. Unemployment is a national phenomenon, and the costs associated with it can not be borne by a local community. It is also broader than a State because the products of the farm or factory are produced for a national or even a worldwide market. The cause of a declining market or rising unemployment thus may originate far beyond the boundaries of a community or State. It is a national problem and the costs can be handled adequately only on a national basis.

Before classifying the major public service needs and possible methods of financing, it may be well to give some consideration to the basic sources of public funds: (1) Income taxes, (2) sales taxes, (3) property taxes, (4) user taxes, and (5) service fees. (The value-added tax is really a form of sales tax.) A public service could be financed with any one or a combination of these sources.

Other taxes such as inheritance taxes, import duties, corporation taxes, etc., each have a separate social purpose and provide funds, but will not be considered here. Also, any tax can be adjusted and levied so as to have a social purpose beyond that of providing revenue. Such a practice can be justified, but the taxpayer should be made aware of its purpose. This problem, likewise, is beyond the scope of this article.

Table 1 lists some of the categories of public services and governmental functions, together with the assignment of responsibility for delivery of the service and the type of tax most suited for financing. It is offered solely to show how a rational decision-making process could be approached. The private sector also should be considered in several of the service needs.

Functions of Property Taxes

PROPERTY taxes are often said to be obsolete. It would be more correct to state that they are obsolete for some purposes. Another view is that since

property taxes are local taxes, an effort should be made to determine the governmental functions that are primarily local in their impact and incidence of benefits.

The property tax may be obsolete for the financing of education and welfare, but it is still a logical source of funds for all services closely related to property and services. If property taxes are limited to the services which have little or no impact beyond the community, then they can be kept in harmony with local services and local needs. These local purposes would be primarily streets and sidewalks, general local government, police protection, local recreational facilities, zoning and subdivision regulations, building code regulations, fire protection and possibly others, depending upon the needs in a particular community. Funds will be needed also to share in certain services administered by the State or Federal Government. These might be for hospitals, streets or local roads, vital statistics, flood control, health and sanitation programs, and the like.

The eventual system for financing education could require the local community or the State to finance the needed school buildings and also allow the locality to add enrichment programs to the educational curriculum, but with their own financing. Some public school offerings could well be financed with fees paid by participating families.

A requirement for financing public education and welfare programs with Federal funds would naturally include the development of satisfactory cooperative administration. Federal financing will also require some degree of Federal administration for assuring fiscal responsibility as well as program content. This requirement should not be an insurmountable problem since the objective of Federal assistance should be to upgrade the below-average school systems and at the same time not restrain those systems where the citizens are willing to pay for better buildings and an enriched curriculum. With welfare programs there is need for an agreed upon national level for humanitarian reasons and for enough uniformity to avoid having families move from one State to another merely for more favorable welfare payments.

Corollary Benefits

SHIFTING most of the costs of public education and welfare to Federal funds would substantially

TABLE 1.—*Classification of selected public services, suggested level of government to assume responsibility and the type of tax to provide financing, based upon incidence of benefits*

Type of public service	Incidence of primary benefits	Level of government to assume responsibility	Type of tax most logical ¹
Education	Individual and entire Nation	Federal: basic, minimum level.	Income.
	Enhance State's competitive advantage.	State: coordinating function . .	Income and sales.
	Local satisfaction of excellence	Local electives and buildings . .	Property and fees.
Welfare	Individual	Federal	Income.
Highways	All highways users in Nation	Federal and State	Gasoline use.
Mail delivery	All citizens of Nation	Federal	Use.
Health and hospitals.	All citizens of State	State	Income, sales, and fees.
Water and sewage.	Citizens of community	Local	Property.
National defense.	All citizens of Nation	Federal	Income.
Judicial	All citizens of State and Nation	State and Federal	Income and sales.
Fire protection	Property owners of community	Local	Property.
Public safety	All citizens of community	Local	Property.
Vital statistics	All citizens—through better decisions by policymakers.	Federal, State, and local	Income and fees.
Census		Federal	Income.
Agricultural production control.	Individual producers	Federal	Fees from producers.
Land records	Property owners	Local	Property and fees.
Recreation facilities.	All citizens of community	Local	Property and fees.
	All citizens of State and Nation	State and Federal	Sales, income, and fees.
General governmental functions.	All citizens of community	Local	Property.
	All citizens of State	State	Income and sales.
	All citizens of Nation	Federal	Income.
Rehabilitation (drugs, etc.).	Those requiring rehabilitation	Federal	Use—causal products.

¹ Use of the term, "most logical tax" refers here to the tax, or tax system, that brings about a better relationship between the distribution of costs and the distribution of benefits.

lower property taxes and bring a number of corollary benefits. Since property taxes then would primarily finance public services closely related to land and other property, there would be little reason to exempt any type of property from local property taxation. The many religious, philanthropic, and governmental properties could well be expected to pay their share of the costs for streets, water and sewage facilities, police protection, and the several services of local government. Getting these properties on the tax rolls would be a help, particularly in municipalities having a high concentration of such properties.

With a relatively low tax on property, there would be less need to strive for increasing the tax base through high density development in urban and urban fringe areas, thus being an aid to more effective planning for better living. County officials then would not be under pressure to promote widespread high-density development with little provision for open space, playgrounds, and parking space. Similarly, the push for attracting industry by many local governments is partly because of the belief that more industry would increase the tax base. Letting the property tax problem influence development decisions injects an element of artificiality into de-

velopment planning that hinders getting the best patterns for maximum human satisfaction for those who are to be the residents of an area.

Taxes must be paid out of income regardless of the type of tax levied, except to the extent that some are paid out of savings and capital. Thus, it appears that more consideration should be given to perfecting the income tax as an equitable source of governmental revenue. Heavy reliance upon local property taxes places a burden on aged people who own their homes. Sales and income taxes are better adapted to older people and all others with low current income, because these levies go down along with the reduced income and lowered consumer expenditures.

The burden of property taxes on older people is recognized by many States and communities in their endeavor to give aged residents homestead exemption or partial property tax exemption. Many States have laws permitting farm properties to be assessed on a use-value basis rather than market value. This practice is relevant primarily in urban fringe areas. As mentioned previously, religious, nonprofit and philanthropic as well as governmental properties are given exemptions from the property tax. All of these complex and sometimes costly arrangements would be unnecessary if property taxes were used primarily for public services related to property—including, of course, the administrative and operating costs of local government, which also is largely concerned with services to property.

The Needed Research

THE fact that some readers may disagree with the ideas expressed in this paper indicates that the topic is a fertile field for research. Only through research can legislators and the public evaluate the possible impact and incidence of proposed changes in the tax laws as a guide for future action.

Research is needed to determine the economic effects of shifting large proportions of public expenditures to income and sales taxes by removing them from the property tax. Would the benefits be capitalized into higher prices for land and other affected property? Some say that land values would skyrocket, that there would be a tremendous capital gain, and lead to a vast withholding of land from use and a lot of other dire consequences. What would be the shift in tax incidence? It is quite

obvious that the sales and income taxes would have to be collected by the State and Federal governments. How would the legitimate local, State, and Federal interests be affected by the needed three-way sharing of revenue and responsibility? How would citizens be assured that the tax levy on property would really be reduced by the amount of the costs of services that are shifted to the other forms of revenue? Would local special interest groups find other public programs to absorb the initial reduction in property taxes? Many more questions could be asked. The skill of the researcher is needed—not so much to invent new sources of tax revenue, but rather to determine the economic impact and incidence of proposed new systems and the administrative structure needed to assure (1) efficiency in the use of the tax dollar, (2) equity among income groups, and (3) fulfillment of the goals sought in the public service.

Much research has been conducted on property assessment procedures and how to get exemptions for several groups within the present system. More attention needs to be given to improving the total system rather than accepting it as given and seeking special favors for special groups. Another question to be answered is whether the level of property taxes has an influence on directing property into higher uses—or if the taxes become high because of prospective higher use. To what extent should taxes be used to influence the direction of land use in the absence of effective zoning regulations?

Conclusions

AN important element in setting up a tax system is the fact that when any one tax becomes what is considered by the individual to be high, his temptation to avoid or evade the tax becomes great. That is one argument for a mixture of types of taxes in the tax system to insure adequate revenue as well as possibly to provide greater equity among citizen groups. However, it should be recognized that there is no perfect tax system and there is no single best tax.

A tax is said to be progressive when the rates become higher in the higher income brackets and claims a higher percentage of total income as the income increases. It is regressive when it claims a higher proportion of the income in the low income

brackets. Thus, the intention of the Federal income tax is that it be progressive. Sales taxes are regressive because low income groups need to spend a higher proportion of their income for consumer goods. As incomes increase, a smaller proportion is spent on consumption, leaving a higher proportion available for savings, capital goods accumulations, and nontaxable services.

Prices tend to allocate and ration goods and services in the private sector. Some of this feature can be incorporated into the delivery of public services by charging some minimum fee for each unit of service so that the user will make some contribution to the cost regardless of his tax contribution. This maintains the progressive feature of the income tax, but asks for an additional contribution by the beneficiary of the services. Some user taxes, such as the gasoline tax, are levied equally on all users regardless of their income. General sales taxes can be made less regressive if food and other essentials are exempted. Another type of adjustment to reduce the regressivity of the sales tax is to allow a given amount to be deducted from the State income tax to compensate for sales taxes paid on necessities.

Law makers need to relate financing to each of

the major types of public goods and services to be delivered. Services which benefit limited and special groups probably should be financed primarily with fees levied on the beneficiaries. Public services which create widespread and diffused benefits can logically be financed with general income or sales taxes. More attention needs to be given to the benefits to be derived from specific public services, and to relate these two financial needs so that the taxpayer will be aware of the benefits derived from his tax payments rather than looking at taxes as a "tax burden"—a term commonly found in tax literature.

Revising a tax system to make it more functional and equitable in terms of the services provided is not, however, a simple undertaking. But whatever approach is used, research should be the forerunner as a means of determining the economic effects of planned change. The various State and regional studies now just getting under way constitute a good—yet modest—beginning. It would appear, however, that an even greater research effort will need to be made if we are to fulfill desirable goals in providing public services through the tax structure.

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SCIENCE NOTES

HEAD SCRATCHING

IN speaking to a group of scientists on the impact of science on the future, South African mathematician A. M. Starfield ended his paper in this fashion:

"If I have stopped during this talk to scratch my head, an ethologist might tell you that this is a characteristic we share with the apes. It is an example of a displacement activity. When a person is under pressure—such as I am in talking to this audience—he is often unsure of what action to take or what to say next. He resolves the conflict by doing something totally irrelevant, but something he is used to doing and can do almost automatically — like scratching his head.

"The scientist is faced with tremendous problems in the future. How many of us are scratching our heads?"—*South African Journal of Science*, Dec. 1971.

A National Research Council panel says the 118,700 tons of fluorides U.S. industry releases into the air each year is not a direct hazard to man, but by effects on plants may indirectly influence man's health and well being.

MINI CHICKENS

Poultry scientists have finally succeeded in breeding a dwarf chicken. It's about two-thirds the size of a normal chicken, consumes 30 percent less feed, and requires half to two-thirds the housing space of a normal bird. But—the trouble is the dwarf bird lays smaller eggs, which sell for 8 to 10 cents a dozen less than large eggs.

Research at the Texas Agricultural Experiment Station, however, is aimed at making the dwarf chicken more competitive by improving feed efficiency and increasing egg size through genetic selection.—*Texas Agricultural Progress*, 18:1, 1972.

Agriculture's mighty midgets, the micronutrients, are gaining more and more importance as a way to relieve soil stress caused by emphasis on high-yield management.

DEEP FREEZE CATTLE

Housing is not necessary for profitable beef production, Michigan Agricultural Experiment Station reports. Cattle wintered at the Northern Beef Demonstration Center near Chatham, Mich., did well last winter in 170 inches of snow with trees as the only windbreak. Some cows calved outside at 23° below zero. Calves were kept warm with heat lamps soon after birth, injected with vitamins, then put with the cow in a stall in a pole building. Calves had the benefit of heating units for 3 to 7 days and then were put back outside.—*Progress in Science*, Jan. 1972.

A halo on algae is no more or less ridiculous than a halo on man.—Ian L. McHarg.

THE CASE OF THE MISSING WATER

Curry and Roosevelt counties in eastern New Mexico contain one of the most prosperous irrigated agricultural areas in the southwest. There are no regularly flowing streams in either county; irrigation water comes from groundwater for which there is essentially no recharge. Rainfall averages about 17 inches a year.

A recent study by the New Mexico Agricultural Experiment Station shows that, because groundwater supplies are rapidly diminishing, irrigated acreage in the region is expected to drop 24 percent by 1980. By the year 2020, irrigated acreage will drop to 7 percent.

What happens then?

The answer is succinctly stated in the bulletin describing the study.

"The alternatives examined in this study offer no satisfactory adjustments for an irrigation farm. Perhaps the study makes more real what surely must come—a day in the predictable future when there will be little or no irrigation. The irrigation farmer's survival will depend primarily on his ability to change—to transfer his resources, primarily management and capital, into other outlets, local or elsewhere. This statement is dramatic only at first blush, because this has been the situation for the

last 20 or 30 years for all farmers and ranchers: to change, or go under.”—*Impact of the Declining Water Supply on the Economy of Curry and Roosevelt Counties*, AES Bull. 588, New Mexico State University.

New York State's problem—to accommodate 12 million more people by the year 2000—will require taking over 1.7 million rural acres for increased urban demand. That's with wise planning. Without planning, the figure will double.

BACTERIA BUG THE BELL

Without bacteria in the earth's crust, tillage of the soil would quite likely never have become one of man's chief occupations. But a certain kind of bacteria underneath a telephone building in Ottawa is eating away at things heretofore thought to be impregnable to bacterial action.

In 1967, officials noted the basement floor of the building had started to heave. Since then, maximum displacement in one area showed heave of more than 2 inches. The situation was serious because the area is used for generators, batteries, and switching units that power telephone service in Ottawa.

Asked to investigate the strange situation, the National Research Council of Canada discovered that autotrophic bacteria belonging to the ferrobacillus-

thiobacillus group were literally disintegrating the black pyritiferous, fissile shale rock—some 500 million years old—on which the building foundation rested.

What had happened was that new construction in the area had lowered the water table, and that—coupled with the 80° temperature in the basement of the building—had provided the right environment for the bacteria to thrive: darkness, warmth, a ready supply of air, and a strong acidic atmosphere.

Given the cause of the problem, the solution was simple: raise the water table by pumping water into the area, and neutralize the acidic condition by adding potassium hydroxide to the water. The heave rate has now decreased significantly, but the higher water table must be permanently maintained to keep the environment unfavorable for bacterial growth.

It was a soil scientist with the Canada Department of Agriculture, incidentally, who provided the initial—and correct—clue to the mystery.—*Science Dimension*, 4:1, 1972

In pilot studies on apple juice production at Geneva, N.Y., food scientists have discovered that adding pectic enzymes to ground apples prior to pressing may be a better way of increasing juice yield than the present commercial practice of adding fluffed wood fiber to the apple pulp.

A WAY OF LIFE—(Cont. from inside cover)

caliber of the honored guests—clean-cut, healthy, confident, and, above all, happy—proud of their vocation.

The significance of the scene and what it stood for was particularly apparent from the head table. And it so moved the chief speaker of the evening, Secretary of Agriculture Earl L. Butz, to begin his remarks in this fashion:

“The strength of America's agriculture—the most productive and efficient in the world—has its roots in farm families. Farm responsibilities continually pass to new and better prepared generations. The outstanding young farmers whom we honor this evening . . . have taken up the torch of a new farm generation.”

Is farming a way of life? Well, when each new

generation picks up the torch with as much vigor and dedication as the last one, there has to be, in our opinion, an affirmative answer.

Let's shift the scene again—this time to the Indiana State fairgrounds coliseum, where the Indiana Farm Bureau was holding its Golden Jubilee in early 1969.

One of the persons attending that convention was, of all people, a sports writer—Bob Barnet of the *Muncie Star*. He was so impressed with what he saw that he wrote a piece about it, which in turn was picked up by my friend Delmer Groves, then editor of *Nation's Agriculture*. This Farm Bureau piece says nothing at all about farming being a way of life. Yet it really doesn't need to, because the scene it describes carries a powerful message about the kind of people who live and work on American farms. Here is a part of it:

"The faces of the men were reddened by wind and sun, but the faces were scrubbed and the shoes were shined and the women looked as if they really could bake a cherry pie, Billy Boy, and not the kind that comes out of a box.

"They looked like working people, wearing their best for an occasion that was important to them. And so they were.

"Inside the massive arena, they took their places and came to their feet when the Ben Davis High School Band played 'The Star Spangled Banner,' and a great many of them sang the words. They repeated the 'Pledge of Allegiance' and meant every word of it.

"They listened attentively while the new Secretary of Agriculture, a fellow-Hoosier named Clifford M. Hardin, from over around Knightstown, told them how badly the world needed them and they nodded when Dean Earl Butz from Purdue told them, 'You should be proud to say, "I'm a farmer."'

"And let me tell you something about these people, neighbor. Not one of the men had long shaggy hair hanging down in his eyes. Not a man or woman was wearing love beads. Nobody heckled the speakers from the back of the arena. Nobody marched anywhere, and the only banners in sight were those of the Indiana Farm Bureau. In other words, these were ladies and gentlemen."

Given the fact that American farmers have qualities that seem to set them apart—even if some

disagreement still lingers about their "way of life"—does it follow, then, that some of these qualities have rubbed off on agricultural scientists? Is an agricultural discipline a "way of life" also?

To a certain degree, yes. I can offer two reasons for this. First, most agricultural scientists still cling to the Jeffersonian dream, which, as you would suspect, embraced both farmers and those who work in the farm sciences. Agricultural science, he said, should be the crown of all sciences. He envisioned the day when "in every college and university, a professorship of agriculture might be honored as the first."

Although Jefferson's dream never really came true, agricultural scientists are not likely to forget that he said what he did—mainly because, with few exceptions, they are products of the land-grant system, and Jefferson's philosophy is deeply embedded in the system, and, quite properly, is frequently expounded.

My second reason is that many agricultural scientists, particularly those in the physical sciences, grew up on a farm. They're not likely to forget that either.

I was flying into Washington, D.C., one day in the company of one of the authors in this issue of *Review*. As we began our descent over the northern Virginia countryside, he remarked to me: "That's the Washington milkshed down there." No one but an agricultural scientist could make a remark like that.

Like farmers, agricultural scientists work closely with the forces of Nature, with biological truths, with the meaning of life in many and varied forms. Society, however, has yet to accord a plant breeder or an entomologist or a soil scientist the same stature it would, say, a physicist or a space scientist. The agricultural fraternity is well aware of this. Yet it doesn't seem to bother them. Why?

If we knew the answer, we would be a lot closer to defining accurately just what their "way of life" is. We agricultural editors like to think that some of the meaning may be embodied in the philosophy of service to mankind through fulfilling the first law of life—the provision of food. And when you stop to think about it, this is what it's all about. Each in his own way—the farmer and the agricultural scientist—both are doing something that brings the same unique satisfactions that few other forms of human endeavor can offer.—W.W.K.



T. C. BYERLY

IT seemed fitting in this issue of Review, which chalks up a milestone or two of various sorts, to include an invitational paper from the man who originally brought our journal from the point of concept to something of substance and reality. That man is Theodore C. Byerly, one-time Iowa farm boy, now USDA's assistant director of science and education, who is marking the path to the closing months of his career as one of the most respected senior scientists in the agricultural

disciplines.

We asked Dr. Byerly to jot down some bits and pieces of philosophy gleaned from his 40-odd years of service as a teacher, scientist, and administrator. He agreed, and we are happy to share his thoughts with our readers. As the headings indicate, the topics are random. But the underlying theme carries one clear message—the opportunities for those who reach out beyond unexplored frontiers of knowledge.—Ed.

Science and the Adversary System

TRADITIONALLY, science in the United States has kept its adversary content at a safe, low visibility level. A doctorate candidate was required to defend his thesis in his oral examination. But as the production of Ph. D's increased and popular professors turned out candidates with whom they were less than intimately acquainted, that defense became rather indifferent and perfunctory.

Even at this point, the adversary content remained low. Indeed, the very quantity of scientific

output defied criticism. Nuclear physics and the concomitant bomb had filled the world with awe. War would be no more, people believed, because no nation would dare risk extinction. DDT had saved millions from plague and malaria. Science could do anything!

A few critics, however, began to speak out. Their ranks multiplied. Those who believed science could, indeed, do awesome things shouted that it should be curbed. Those who believed that the indirect effects of science were mostly evil—even when primary ef-

fects were ostensibly good—joined them.

On a more serious note, youth looked at the material products of science-based technology and became bored with them. Science had produced nothing that seemed important to them. And so they retreated, in disturbing numbers, to a world of sensual perception, sensitivity, and hallucinations.

Who Benefits from Agricultural Research?

I came to USDA for several reasons. Obviously, one reason was the offer of a job. That job offered me an opportunity to use and further increase my skill in developmental biology. My first research was on the hatchability of chicken eggs—quite a logical place to begin.

The work was challenging, because I could sense the frontiers that lay ahead in this area of research. Discoveries soon came—first in the nutritional requirements for hatchability, then in genetic factors affecting it. But there was more to be learned. The mechanical and other physical environmental factors external to the egg needed to be regulated to meet the requirements of the developing embryo. In time, these factors were clarified—not by me alone, but by a lot of people working in USDA, in the State experiment stations, and in other institutions here and abroad.

The results we obtained never had time to gather dust. Feed manufacturers, poultry breeders, and producers soon put them to work. What happened after that is well-known history. Chicken became one of the lowest cost meats, because the economic benefits from the application of research were quickly passed on to consumers. Not so in some other areas of research, is it, where economic benefits are likely to become sources of further profit?

I have seen many changes in the poultry enterprise. One which was inevitable, I suppose, was the trend to bigness—along with integration of every facet of the whole production and marketing line. America produces billions of broilers every year; yet most of them come from just a few thousand farms.

Working for Uncle Sam

PEOPLE used to say, when they took a Government job, that they were “working for Uncle Sam.” Could that have been one way of softening the degree of anonymity that goes with working for a big outfit? The anonymity is still there; it has its

good points and bad points—even in research, which is no different from other kinds of jobs in this regard. The Department of Agriculture has more than 4,000 scientists working on agricultural research problems; at the 53 State agricultural experiment stations, there are about 10,000.

Yet despite its bigness, the Department provides challenges and opportunities for scientists in almost every discipline—for those who can reach out beyond unexplored frontiers of knowledge, for the data gatherers and analysts needed to apply discoveries.

I think all of us who work for USDA know the Department is just as good as we make it. For, indeed, the Department is us.

Is Science Austere?

IT helps to know what we’re looking for in research. A writer named Philip Bailey once said: “Who never doubted never half believed; where doubt, there truth is—’tis her shadow.” Our confidence in the findings of science rests on their objectivity, their freedom from bias.

But when you define the scientific method, you have to use some rather austere terms to set the limits: (a) stating the question in answerable form, (b) developing one or more hypothetical answers, (c) testing the hypotheses with relevant and sufficient data.

At its best, this method results only in a demonstration that the probability that no other hypothesis than the one tested is more likely to be correct within the determinable confidence limits. A valid statement, but it may require a bit of pondering.

Agriculture and the Environment

THERE’S a simple fact that we agriculturists ought to keep repeating whenever we get the chance: All of us—farmers, ranchers, foresters, and many in the supporting disciplines—are managers of the environment. As my friend Jim Horsfall says, we were environmentalists long before the word caught the public fancy.

Our National Forests are managed for water harvest, wildlife habitat, recreation, and natural beauty as well as for timber production and livestock grazing. Our Soil Conservation Service and its 2 million cooperating land holders have stayed the ravages of erosion in much of the country. Even so, the job is

not yet done. From a quantitative standpoint, the task of controlling the entrainment, transport, and deposition of sediment by water and wind is still our biggest pollution problem.

Protecting and increasing the productive capacity of our forests, ranges, croplands—and of deserts, tundra, and nonfarm land is research based. Research provides the information which has enabled us to limit our harvested acreage to 300 million.

It gives me some satisfaction to know that highway builders and urban developers have had to turn to the soil sciences in agriculture to protect cuts and fills and to use the soil wisely as living filters.

We agriculturists ought to be the first to admit, though, that our knowledge is imperfect. Chemicals used to protect our crops, forests, homes, and public places against pests have had some adverse effects on nontarget organisms and the environment. It is obvious, of course, to say that we need more research to solve these problems. But not just research for the sake of research. More emphasis is needed on studies of ecosystems. We need research that will enable us to use our land truly according to its capacity. We need research that will enable us to enjoy clear water, abundant fish and wildlife, and to continue to enjoy a safe, varied, and abundant food supply. Is this too much to expect from research? I think not.

We are just now learning to do research that will enable us to predict impact of change in particular parameters on whole systems. This is fine. But I suspect that some of us may be confused by the beauty and intricacy—or worse—the apparent simplicity of our models. If a model cannot be validated, it must be discarded.

The Good Old Days . . . and Today . . . and Tomorrow

THEN there were the 1930's. The world of science in agriculture was reborn. Vitamins, hormones were all about waiting to be discovered. Sewall Wright's research with guinea pigs at Beltsville had laid the groundwork for population genetics. Hybrid corn was finally moving from the laboratory to the cornfield despite the hardened, university-entrenched, conventional dependence on phenotypic selection.

But the old has refused to die. In 10 short years following World War II, phenotypic selection on a grand scale literally revolutionized our broiler industry. Dominant white, the broad breast of the

Cornish, and hybrid vigor without inbreeding changed the appearance and genetic capacity for feed efficiency of billions of chickens to be hatched the world around.

The "Chicken of Tomorrow"—an idea of Howard (Doc) Pierce—was picked up and developed by many poultry breeders and melded with other stocks from many sources to produce male and female lines which, when crossed, gave high growth rate, feed efficiency, hatchability, and survival. H. L. Shrader did missionary work through Extension. A lot of us supplied jawbone.

But the achievement was that of poultrymen using only a modicum of science.

The difficult portion—conquest of disease—has a larger science content or seems likely to have. It, too, is mixed.

Poultrymen of the 1930's depended on semisolid buttermilk—and bought it literally by the barrel as a palliative for the ever-present coccidiosis in their growing chicks. There were nostrums aplenty—for domestic animals and humans too.

Scientists advocated a daily cleanup of poultry houses containing infected flocks so that voided coccidial stages would be removed before they ripened to infective capacity.

But, here, the truth was not enough. The labor cost for daily cleaning exceeded the value of chicks saved. Then, studies in Ohio showed that built-up litter gave better results—perhaps because a few coccidia obtained from the old litter protected the chicks from further infestation.

Eventually, the old-fashioned buttermilk remedy and the nostrums were replaced by the newer coccidiostats of laboratory-proved effectiveness. Along the way, arsenicals came in. A compound called 3-nitro-4-hydroxyphenyl arsonic acid was demonstrated to have both coccidiostatic and growth promotant value. We had no need to be concerned about any likelihood of arsenic accumulation in their bodies because of the short life span of broilers.

Serendipity soon produced other growth promotants—the antibiotics. Their discovery as growth promotants was a byproduct of the testing of crude preparations as a source of vitamin B₁₂. Vitamin B₁₂ was in the chlorotetracycline products when tested, but growth promotion was also there at amazingly low levels—10–20 ppm.

Now, such use is questioned and may be restricted

because populations of bacteria resistant to antibiotics develop in the presence of antibiotics. Since bacteria of animal origin, for example, *Salmonellas*, reach man through his food supply, any that carry resistance might transfer that resistance to the normal bacterial flora of the human gut. Moreover, gut organisms may and often do infect the urinary tract, and since antibiotics may be useful in controlling such infections, antibiotic resistance is clearly a hazard to human health. Whether or not use of antibiotics as growth promotants constitutes a real hazard in this way is likely to be fiercely debated in the near future.

A recent discovery which may be epoch-making is the newly developed vaccine against Marek's Disease—a virus-caused cancerous disease of poultry. This discovery rests on 30 years work of a small, dedicated staff of research workers at the Regional Poultry Laboratory at East Lansing, Mich.

A serious question pervades all these accounts: Should we apply technology as soon as the direct benefits are demonstrated to exceed its direct costs?

Or, to state it another way, should all indirect costs—and benefits—first be demonstrated before technology is put to use? We are moving in the latter direction, but here we face probability again. Many indirect effects, both beneficial and adverse, are likely to be discovered *only* when technology is applied. The British physicist, John Tyndall, had something to say along this line; we might do well to bear it in mind:

"To look at his picture as a whole, a painter requires distance; and to judge the whole scientific achievement of any age, the standpoint of a succeeding age is desirable."

Standing on the Verge of Discovery

THERE are patterns in the advancement of science—if you look for them. Some discoveries come quickly, almost unexpectedly. Others result from programs that grind out the findings on schedule. But there are exasperating situations too, where scientists appear to be standing on the verge of discovery—wondering when the breakthrough will come.

Physiologists have been standing on the brink of controlled estrus (ovulation) and hence of synchronous parturition for years—or of egg laying, for that matter.

Early attempts to induce estrus by using estrogens produced heat with no ovulation. Current combinations of progesterones and estrogens are manipulated to produce both heat and ovulation, followed sometimes—but with too low frequency—by conception.

Multiple births through hormone administration have been demonstrated redundantly for 25 years, too, but with little evidence, that twins, not litters, are uniformly achievable.

Byproducts such as diethylstilbestrol are widely used to improve rate of gain in feedlot cattle. But their use is now being questioned increasingly by those who are concerned with possible residues. Again we have the question of weighing benefits and indirect effects. Time will tell. We have all the time in the world, but it is not enough.

A Cow for a Horse

AT the end of World War II, UNRRA dispatched several hundred thousand horses to the devastated countries of Europe. Lads of the "Plain People"—Mennonites, Brethren, Amish—went as hostlers with General Hershey's approval. They and the horses helped get food production in Poland, Yugoslavia, and Greece in full swing again.

Soon thereafter, horse and mule research, including the Morgan Horse Farm at Middlebury, Vt., were terminated. The Morgan was an American dream realized—is still a beautiful, sometimes useful, utility animal. If recreation is essential to man's well being, the day of the Morgan is not past.

But horses and mules are largely gone from the American farm scene. So are the Army horses and mules. Three of the remount stations—Front Royal, Va., Fort Robinson, Nebr., and Fort Reno, Okla.—were transformed to beef cattle research. Fort Robinson has now given way to the Meat Animal Research Center at Clay Center, Nebr. Times change—usually for the better.

Of Who Did What and to Whom?

PLATO said: "There are three acts which are concerned with all things; one which uses, another which makes, a third which imitates them."

In science, there is a long-fixed tradition that priority of discovery is the highest achievement of scientists. This tradition becomes more and more obscured by the development of teams of scientists

making multidisciplinary attacks on a single problem.

Devices for assignment of credit vary widely. Some senior scientists, major professors, for example, refuse to have their name on a paper when the actual work was done by junior scientists or graduate students. Others always insist on being the senior author. More frequently, grants are made to senior scientists who provide umbrella support for a flock of junior scientists or graduate students.

This problem, a phase of the general problem of plagiarism, reminds me of Montaigne who dealt with that topic with desperate dicta: "The bees pillage the flowers here and there, but they make

honey of them which is all their own."

How may one reconcile the proprietary value of ideas—apparent products of the human mind—with the cult of objectivity which requires their evaluation wholly apart from their authorship?

Data from every source may be synthesized redundantly with fresh lots. This exercise is often less fruitful than a fresh start, discarding all the data of the past, obtaining fresh, relevant, and adequate data to test the hypothesis at hand. Waiting until after the fact may sometimes be soon enough to compare a current finding with the past. But we do often innocently, ignorantly, fruitlessly rediscover things long known.

Forestry Research in New England

HOPE that the forestry economy of New England may be boosted to some semblance of its former level has received added impetus from the stepped-up emphasis on research, as evidenced by the recent announcement that two new Forest Service research laboratories will be built in that area.

A new special laboratory for maple sugar research will be added as a facility of the Forest Service's Northeastern Forest Experiment Station at Burlington, Vermont. A second facility will be a new forest sciences laboratory which will occupy an 8-acre tract on the University of New Hampshire campus at Durham.

At the maple sugar laboratory, sugar maple trees will be used for part of the landscaping and as test trees for maple sugar research. A tree nursery will be maintained at the rear of the tract for conducting studies on outplanting, regeneration, and genetics. The new laboratory will be a sizable expansion of present facilities in downtown Burlington.

Scientists will work with university and industry cooperators to improve production in the maple sugar industry which has dwindled from more than 5 million gallons annually at the turn of the century to only about 1 million gallons today.

The new facility at Durham, N.H. will permit expansion and intensification of research on prob-

lems unique to New Hampshire and New England forest environment. Research personnel are presently housed in a Durham office building. Of particular importance is the laboratory's watershed research unit. Scientists in this program study the energy, water, and nutrient cycling processes of New England forest ecosystems so that man's manipulation of forest land can be planned and conducted to avoid adverse effects and provide optimum benefits.

The genetics research unit at Durham is working to develop new varieties of trees that will produce maximum yields of wood fiber in a short time. Emphasis is on development of a white pine that will resist the white pine weevil—an insect that causes \$7 million damage annually in the Northeast.

Research on growth, composition, and culture of valuable northern hardwoods includes the production of high quality sugar maple, yellow and paper birch, and white ash for use in furniture, paneling, novelty items, and related uses.

The Durham tree diseases unit, the only pioneer forest diseases research project in the Nation, is studying the causes of wood degrade and methods for protecting quality hardwood trees from stains, decay, and other damaging factors.

Forest recreation research at Durham aims to stimulate and assist private recreation managers to plan and develop outdoor forest recreation facilities.



FORUM

IMPLICATIONS OF NEW ECONOMIC POLICIES FOR AGRICULTURE

FARMERS in the United States are now facing some new and potentially important issues that grew out of the wage-price freeze of August 15, 1971, referred to as Phase I, and from Phase II which followed. These issues are concerned with economic equity for farmers in relation to other groups in society, with economic organization, and with productivity, or efficiency, not only in agriculture, but also in other sectors of the economy.

The new national economic policy of direct public intervention in private wage and price decisions became necessary because traditional monetary and fiscal measures were judged to be inadequate. That is, monetary and fiscal policies appeared to be incapable of maintaining reasonably high levels of employment and income without generating an unacceptable rate of inflation. Furthermore, inflationary tendencies seemed to be getting worse. Prior to the imposition of wage and price controls, a slowdown in the economy and rising unemployment had little influence on general price rises.

Possible Causes of Increasing Inflationary Bias

WHY have inflationary pressures seemed more persistent? Several reasons have been advanced. It is widely believed that a basic cause is to be found

in the changing organizational structure of the American economy. Some economic groups appear to be increasingly powerful and able to influence price and wage decisions independent of market forces. The wage-price spiral may be intensified when effective competitive alternatives are either unavailable or inadequate. Moreover, in periods of slack demand, prices and wages do not decline in most sectors of the economy. Output and employment are reduced instead. So there is upward price flexibility and downward rigidity—a kind of ratchet effect. The classic exception of course is agriculture, where commodity prices are flexible downward as well as upward.

In recent years, the inflationary bias associated with imperfectly competitive price and wage behavior seems to have been further aggravated by dynamic changes in the economy. Rapidly advancing technology has created new industries requiring specialized people and equipment. Faster adjustments have been called for, but time lags are involved in training new workers, moving people, building new plants, perfecting new machine tools and in learning how to organize and manage new enterprises effectively. Meanwhile, there was upward pressure on wages and prices in the new industries that was not matched by offsetting downward movement in wages and prices in the older industries. And when demand cutbacks hit the high technology industries, such as aerospace and defense, many highly trained people joined the ranks of the unemployed. Often no other jobs of any kind could be found in the sections of the country where these industries were located.

A similar longer run pattern has also been observed in many of the service industries. Demand for services has been growing and employment increasing in such endeavors as wholesale and retail trade, finance, marketing, insurance, real estate, medical care, education and government as compared with manufacturing and especially agriculture. According to a study by the National Bureau of Economic Research, service workers increased from 40 percent of the total number of people employed in the United States in 1929 to 55 percent in 1965, while agricultural employment declined from 20 to 6 percent.¹

This article was adapted from a paper presented by Dr. Paul L. Farris, Dept. of Agricultural Economics, Purdue University, at Farm Science Days, Lafayette, Ind., on January 11, 1972.

¹ Victor R. Fuchs, *The Service Economy*, National Bureau of Economic Research, General Series No. 87, 1968, p. 19.

Price increases for many services have run ahead of price advances for products produced in other sectors of the economy. At least two major reasons appear to be involved. On the one hand, the supplies of qualified people and facilities in some service industries have not kept pace with demand. Notable examples are physicians and hospitals. On the other hand, efficiency gains have come more slowly in the service industries than in manufacture and agriculture. So, given a rising demand for services, slow output response and slow growth in productivity produced upward pressure on prices that again was not matched by offsetting price declines elsewhere in the economy. The one major sector of the economy where prices typically have responded more sensitively to demand and supply conditions, that is, agriculture, was declining in relative importance.

National Economic Policy Choices

THE nation currently faces some hard choices with respect to overall economic policy. At the outset we can ask whether we will attempt to maintain high level employment, output, and income. But I think this can be answered quickly. To fail to use our resources fully and effectively in the face of the

numerous and growing demands for the benefits, goods, and services that our economic system is capable of producing would be economic folly. A policy of slowing the economy sufficiently to stop inflation would bring severe hardship to many people. So it seems clear that an important national objective will be to promote prosperity.

Given this commitment, the next question is whether we will take the necessary steps to make the economy more workably competitive, sensitive, and responsive to market demand and supply conditions so that the need for direct wage and price controls will be reduced. To do so would require that economic power be held in check and balanced against more readily available market alternatives. It would also help if greater emphasis were given to programs of manpower training and mobility—either in transferring people to where the jobs are or bringing more new jobs to where the people are. Finally, it will be of fundamental importance to increase national productivity, particularly the efficiency of our service industries. This implies strong emphasis on scientific research in the natural, physical, and social sciences, manpower training programs, and education.

But these are long-run goals, and we must realize that, important as they are, much time and ef-



fort will be required for programs to achieve them to produce results. Moreover, some attempts to increase competition, such as restricting the power of labor unions, preventing mergers by large corporations, and encouraging new competition in concentrated industries, have historically encountered great opposition. So if we back away from actions which would make the economy more workably competitive, we are likely to have some kind of direct intervention, or guidelines, affecting wage and price decisions for the indefinite future in order to achieve the performance goal of less inflation.

What are the implications for agriculture in this kind of economic environment? What of the more distant future? And how about the role of agriculture in the formulation of national economic policy?

Short-Run Considerations

UNDER Phase II restraints on wages and prices, farmers will obviously benefit—at least in the short run—because prices of raw farm products are not directly controlled. On the other hand, prices of farm input items such as machinery, fertilizer, petroleum products, fencing, and building materials are controlled. Restraints on prices of these items enhance the purchasing power of farm income relative to what it otherwise might be.

Of course, if controls are applied to retail food prices, then prices paid to farmers would be restrained. However, direct control over retail food prices seems unlikely. For example, at the 1972 National Agricultural Outlook Conference, Secretary of Agriculture Earl Butz cited four points illustrating why controls either should not or could not be effected: (1) Farmers have not caused inflation, because food purchases require only 16 percent of take-home income—the lowest percentage ever. (2) A survey of history shows that controls will not work for commodities as perishable, as seasonal, and as varied as food products. (3) Farm income should not be suppressed because per capita income of farm people is only three-fourths as high as that of non-farm people. (4) Agriculture—unlike industry—is highly competitive, sometimes harshly so.

Long-Run Implications

IF wage and price restraints continue over the longer run, other issues can be expected. These arise from two important assumptions made by the Price

Commission and the Pay Board.

One assumption seems to be that efficiency gains will be retained at least in part, by labor, capital and management. In other words, labor, capital and management groups will be permitted to retain the benefits from increased efficiencies in their industries rather than pass them on to consumers in the form of lower prices for existing products, improved products at existing prices, or some combination of the two. This is generally consistent with historical behavior in many industries and opposite to that in agriculture where efficiency gains tend to be passed on rather promptly to consumers rather than captured by farmers.

The second key assumption was that incomes, such as wages and salaries, will be allowed to rise to offset the purchasing power eroded by further inflation.

Thus, the longer run agricultural policy question is whether and how, if Phase II continues for any length of time, the operating rules relative to productivity and inflation should be applied to farmers. If these operating rules become embedded in national policy in the nonfarm economy, will it be more difficult for farmers to obtain economic justice in relation to other groups in society?

Of course we cannot be sure at this time. And if these income considerations were applicable to farmers, questions of implementation would arise, and further study and discussion would be necessary. In general, the possibilities would be for productivity and inflation considerations to be incorporated in various ways in Government farm programs, in legislation affecting farm producers, and in the organization and functioning of farm groups such as cooperatives and farm organizations.

This discussion of longer run implications for agriculture under Phase II points up the significance to farmers of the competitive structure issue that we face as a Nation. Our historical philosophy has favored a market economy with as much latitude for free enterprise and independent decision-making as possible and in which buyers and sellers are sufficiently numerous and vigorous to impose competitive checks on each other. It has been our national policy to take steps from time to time which would nourish competition, sometimes by restraining excessive power, sometimes by encouraging new competitors or enabling weak competitors

to become stronger.

This historical national philosophy is currently undergoing a critical test. Clearly, if we abandon this philosophy, in both thought and practice, returns to various segments of society will be set increasingly by administrative decisions, such as those under Phase II, rather than the market. Such decisions will be importantly influenced by economic power and the bargaining strengths of various organized groups. The emphasis on group bargaining throughout the economy will increase. Farmers will need to consider how they can best compete in this kind of economic environment. Consequently, the broad policy direction taken by society on the competitive structure issue deserves thorough consideration by all citizens, and farmers have an important stake in the outcome.

Research and Education Emphasis

A related public policy issue involves actions that would make the economy more efficient and productive. Such actions would need to include increased emphasis on research and education, both public and private. New research knowledge can help in several ways. One way would be to develop new products, processes, and procedures that would challenge existing monopolistic positions and increase competition. Another would be to increase efficiency throughout the economy, particularly in our service industries. Both would help relieve inflationary pressures.

But there is another important reason for increasing national productivity. We face serious competitive challenges from abroad. In order to compete in the world environment, the United States will continually need to build to its strengths where we have natural advantages. These seem more and

more to be along the lines of scientific advance, management, science, and organizational capacity. Our ability to develop technologically advanced systems of production, marketing and finance and to manage such systems, enterprises and institutions in the pursuit of particular objectives will have a major impact on our success in competing for world markets.

U.S. farmers, too, will be facing a tougher world-trading environment over the next several years than at any time in recent history. The efficiency of our agricultural plant, along with our handling, transporting, processing and marketing capabilities, will significantly affect our ability to compete for agricultural markets abroad.

Hence, to rise to our full economic and social potential will require strong emphasis on advancing our basic scientific and social knowledge and on well-trained and educated people. The sometimes fashionable criticism of such efforts in recent years may be a very shortsighted practice. Clearly, educational institutions also face important challenges in addressing themselves more directly to solving basic scientific and social problems relevant to society's needs.

Looking ahead, much will depend on our attitude, which I think should be optimistic. We have learned some important things about our economy, and we are learning more. As a society I think we are becoming more analytical. Our continuing challenge will be to modify our man-made social and economic institutions so they will serve us better according to our most basic values.

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Whatever Happened to Guineaas?

DURING the past 10 years, poultrymen in France and Italy have developed a highly profitable industry that may offer some real potential in the United States. In those European countries, commercial production of guinea fowl is a fast-growing enterprise.

Most of us remember flocks of a few guinea fowl roaming freely on the farm, roosting in trees, serving little else than as decorations or as "watchdogs" by raising an awful din when strangers approached.

I recently returned from a year of research at the Poultry Research Station of the National Institute for Agricultural Research located near Tours, France. During the year I visited many commercial poultry operations.

One guinea organization I visited is almost certainly the largest in the world and is an integrated breeder flock and hatchery enterprise with a production exceeding 8 million keets (baby guineas) a year. All of this has developed in less than 10 years. Much of the success is due to the cooperation between the producer and government researchers through the liaison of an extension specialist. It was discovered that egg production of guinea hens housed in cages was vastly superior to that in floor housed birds. They also learned that techniques of artificial insemination which had been developed for chickens applied equally well to guinea fowl.

Currently, this single commercial operation maintains 70,000 to 80,000 hens in production year-round. The hens lay for 9 months, producing 150 eggs each. Fertility and hatchability levels of 90 and 80 percent, respectively, result in an average yield of 110 keets per hen. The hens are kept in modern poultry houses in three-tiered laying cages four or six to a cage in a manner similar to that used for commercial egg-producing chickens. Males

are similarly housed in a separate part of the building. Two men inseminate 4,400 hens per week while caring for the birds and collecting eggs. All-pullet flocks are used because production in the second year falls to 70 percent of that in the first year.

Day-old keets sell for 24 to 40 cents depending on season and contract. They reach a weight of 2.6 pounds at 10 to 11 weeks of age and generally sell for 32 cents per pound liveweight. They have a dressing yield of 80 percent which equals or surpasses that of broiler chickens. By 10 to 11 weeks of age, the males and females do not differ in body weight (an advantage to the processor), but at the adult stage, females weight 3.90 pounds and the males, which are smaller, weigh 3.63 pounds.

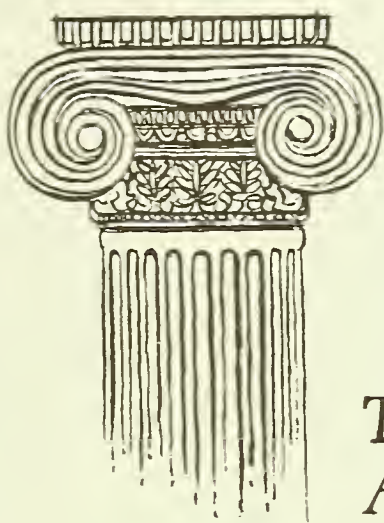
Guinea fowl respond dramatically to genetic selection, since they represent an untapped pool of genetic variability. Research is likewise just beginning to determine the nutrient requirements of this newly exploited member of the poultry family.

In France, dressed guinea fowl is available in butcher shops and supermarkets throughout the year, and its consumption ranks second after chicken and ahead of turkey. The meat is prized for its slightly "gamey" flavor and is an ever-popular restaurant dinner. Much of this popularity results directly from a cooperative advertising campaign by the producers.

In our affluent American society, there is room for greater diversity in luxury foods. An enterprising producer could create a lucrative business raising guinea fowl if he established the market as his production developed.

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